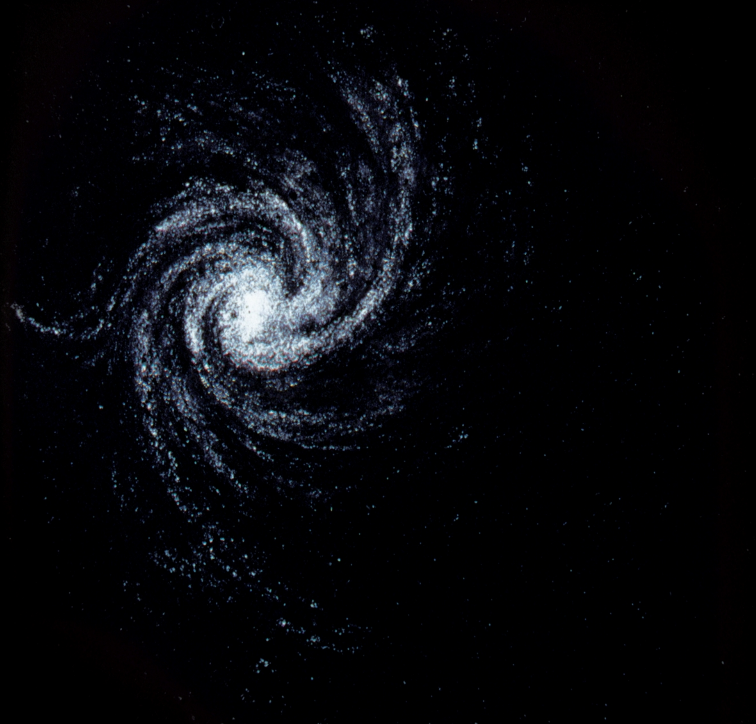
# Nebulae

## A Backyard Cosmography



Dana Wilde

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## *A Backyard Cosmography*

Dana Wilde

***2012***

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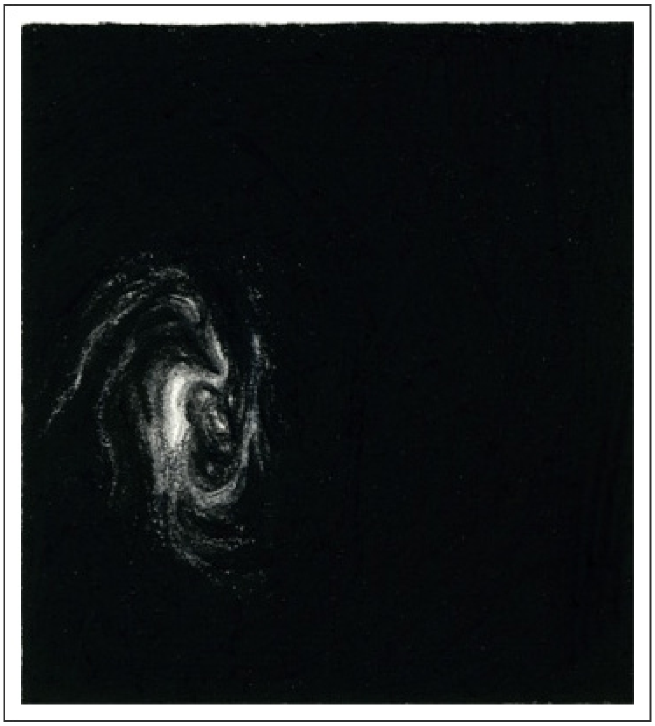
*Invaluable encouragement in these writings came from, to name only a few, Bruce Holsapple and Jim Bishop; William Hathaway; Richard Collins; Mark Bruhn; and Bonnie and Jack, all ways and always.*

"… by the term 'Universe,' wherever employed without qualification in this essay, I mean to designate *the utmost conceivable expanse of space, with all things, spiritual and material, that can be imagined to exist within the compass of that expanse*."

– E.A. Poe, *Eureka: A Prose Poem*



# PREFACE

Sky nebulae really started to be puzzled over in earnest during the seventeenth century, after people started pointing telescopes up there. There were these fuzzy clouds of light no one had ever seen before. What were they?

The better the instruments got, the more clouds of light there seemed to be. Those early astronomers knew they did not know what they were seeing, but as humans do, they threw out ideas, theories and detailed descriptions of the phenomena in the effort to find out. One early thought was that the nebulae were clouds of gas forming into planets like ours. Another was that they were island universes of stars, or in other words, galaxies.

Well, the telescopes and accompanying instrumentation got better and better, and by the twentieth century the unknown clouds of light were of different kinds. Some were groups of stars (clusters, globular clusters and galaxies). Some were shells of gas around dying stars (called, in the original eighteenth century phrase, planetary nebulae even though it turned out they were nothing to do with planets). And some were actual clouds of gas and dust, now generally spoken of in three different categories: emission nebulae (clouds which glow in the presence of ultraviolet radiation); reflection nebulae (clouds which are reflecting nearby starlight); and absorption nebulae (clouds which are dark and seen in silhouette against other brightnesses).

As with all serious human inquiry – scientific, philosophic, religious – it took centuries of minute observation and intellectual energy to get these descriptions into focus. The physical picture of the cosmos is a lot clearer than it was two hundred years ago, but in some ways the clouds of scientific unknowing are greater than ever. By the 1990s it was evident to cosmologists that upwards of 90 percent of all that apparently exists in the universe as we imagine it has not been seen or even detected. In fact there are some very bright people toiling away over data distilled from far-distant starlight who are pretty sure the universe as we see it is only one among a possible infinity of universes.

And that's just the physical cosmos that science has a shot at accounting for. There are whole other activities inside the mind that just escape biochemical statisticry and that appear, judging by the glints and lightnings that erupt from them, to signal the existence of other worlds the way quantum, relativity, astro and cosmological physics signal the existence of other universes.

Somehow, when your mind is pointed in a certain direction, the worlds and universes converge in starlit places that are sometimes as vivid as moonlight and sometimes as cloudy as a rambling dream. Shafts and glimmers light up the inward clouds of unknowing and throw reflections and silhouettes of weird shapes onto the surface of your mind. The essays in this book are reflecting back those glimmers and shadows in the stardust, like reflection nebulae, I guess, and in a couple of rare cases where stargazed images erupted in energy of their own, emission nebulae.

Whatever's actually happening out there and in here, everything in this book, as in its predecessor out of the Maine woods, is meant to generate a bright spot. I can't enumerate all the kinds of brightness there are, because in truth I've caught glimpses of precious few of them and, if the writings of the masters are any indication, those glimpses have been nebulous. Thoreau glows inside all of these pages, though he himself did not talk about the stars much. He might have, I imagine, if he could have gone for close-up walks among them, or if he'd had access to the imagery and gigadata that have exploded our understanding of the universe since the 1850s. Like Henry, I rate the value of a fact by its potential to blossom into "a truth" – which is a multidimensional kind of brightness radiating from we have no idea where into we have no idea where, stuck as we seem to be here inside the four-square cloud of space-time.

# STAR SYSTEMS

## STAR-STRUCK

*Star light, star bright,*
*First star I see tonight,*
*I wish I may, I wish I might*
*Have the wish I wish tonight.*

I wish I might get the leg of this telescope stand to come unstuck. One of the slotted flanges that steady the three wooden legs is jammed and the whole thing, tube and all, won't stay upright.

On the top of this hill in Troy, I can see a huge expanse of stars above me, and even in the September chill it's sending cosmic shivers down my spine. I can make a lot of sense out of starlight, poetry and the distance from here to Saturn, but this simple tripod, which Leonardo da Vinci would have compared to a kid's erector set, is severely challenging me.

I've set up this small telescope hundreds of times. Tonight I can't even loosen the wing nut that pins the flange. Last time, a clamp seemed stripped and the thirty-inch-long tube kept slipping down. A little while later it got tired of the joke and unfroze by itself.

I pull and twist at the wing nut and the flange, and work the wooden leg back and forth hoping something will come loose without breaking. Suddenly the leg and mount part company, and now I'm kneeling in the dark with the heavy mount and tube teetering in one hand and the leg clutched in the other.

"Jack," I say. "Can you help me out, here?" Jack, my fourteen-year-old son and stargazing assistant, has been unpacking lenses, filters and star maps from the car nearby.

"What's broken this time, Dad?" he says.

"Can you just grab the mount and hold it?"

He takes the tube and mount, and I push the leg back in. The flange slides easily back and forth now, no one knows why, and I tighten the wing nuts that steady the tripod.

The telescope now firmly planted in the grass, I step back and look at the sky. Fall is said to be the best time for stargazing in Maine because the air is clear of the summer humidity and winter is not yet freezing your hands solid. Stars are burning up there, thousands that you can see and billions you can't. Soon we'll have an eyepiece fitted to the telescope and millions more pins of light will be revealed to us.

This is a reflecting telescope, as opposed to a refracting telescope. It works by reflecting light off a mirror (ours is four and a half inches wide) in the back of the tube, into another mirror that bounces the light up through a lens that magnifies it into your eye. A refracting telescope – with the narrow tube, like you see on the shelf at WalMart – guides the light directly into your eye by "refracting" it through lenses.

Tonight there are a few clouds and some glow from the waning moon, and no planets strike this early, but we should be able to get decent looks. Jack has readied the equipment, including binoculars, a planisphere (a plastic chart with a wheel you can adjust to show the main constellations any night of the year), maps for finding faint objects in small chunks of sky, a flashlight, and a laptop computer with a star-locating program. For regular excursions, it's good to bring a notebook too. Ours is missing from the green army pouch, but no matter.

Jack tightens the eyepiece into the sleeve protruding from the upper end of the tube. I remove the caps from the finder scope, sort of a pirate's looking-glass attached to the tube's side.

We decide to look at "the galaxy," which is our code for the one easily seen galaxy in the Northern Hemisphere, M31 in the constellation Andromeda. You actually can see it, a faint blur, with your naked eye if you know where to look on a dark night.

I swivel the tube toward the east and kneel down to squint through the finder scope. My hat pushes the whole tube off center. This has happened two hundred or three hundred times, but I never seem to remember. Exasperated, I turn the hat backwards and peer into the patch of sky where M31 is located. I move the tube in circles by hand, searching.

Aha, there it is, a whitish smudge. I position it in the crosshairs of the finder scope, then stand up to look through the main eyepiece.

When you look through a telescope, you keep both eyes open. This seems like strange advice since only one eye can look through the lens. But if you train yourself to look through one eye, eventually a clearer image develops without the muscle strain involved in clamping one eye shut. It's almost a metaphysical problem, seeing through one eye with both eyes open.

I look through the eyepiece. There's the galaxy near the center of the circle. It's still just a blur, like a wisp of spit in a lake. But this is where your imagination takes over. M31 is actually a gigantic collection of stars. The Sun is a star. These 700 billion suns are so far away (2.5 million light-years) that even magnified fifty times the whole bunch of them is just a cottony fuzz.

It shows up well against the black of space. I gesture for Jack to have a look.

He bends to the eyepiece.

After a few seconds he says, "Oh well."

"What do you mean?"

"Clouds came."

I look up. A few mackerel ribs have obscured Andromeda and four bright stars nearby, the Square of Pegasus. Dang. Until I started star hunting, I never realized how cloudy it is in Maine.

More westerly, stars are still shining. I point out the Summer Triangle – the stars Vega, Altair, and Deneb which is almost directly overhead this time of year, the faintest of the three and in the constellation Cygnus, the swan, also known as the Northern Cross. We point the telescope at Vega. It may well have planets revolving around it, but all we see in the eyepiece is a crystal white dot. It's burning up there, relatively nearby at twenty-six light-years away, but even that distance is too large for the telescope to make any difference whatsoever in size. In fact, while the image is sharper, the star looks even smaller there in the telescope blackness.

The stars overhead seem to swim across the circle of view at about the speed of a watch's minute hand, because the Earth is turning. So I twist two knobs to bring Vega back to the middle of the circle. Jack peers into the eyepiece.

"I know it's not *Final Fantasy*," I say. "But it's a lot better for your soul."

We swivel the scope around toward the northern stars, which are seen year round – the seven main stars of Ursa Major, also known as the Great Bear or Big Dipper, and above it Ursa Minor, the Little Dipper. The cold-white star at the end of its handle is Polaris, just about due north all the time, around which all the stars turn. In about twelve thousand years, a certain slow wobble of the Earth will have shifted Polaris away and made Vega the North Star. Wheels within cosmic wheels.

We get the maps and flashlight out and try to make sense of the myriad of white specks in Ursa Major. There's galaxies in them thar stars. Mostly too faint for us to find quickly.

The telescope is now behaving splendidly, even for a machine. Or is it just that I'm relaxing in the chill and starlight? I peer at the double star Mizar-Alcor in the joint of the Dipper's handle.

Something brushes my pantleg. I look down. Great.

"Don't move," I say.

"Why?"

"Skunk."

Jack instinctively bolts, and the skunk raises its tail. Oh man, there's no choice now but to run. I leap like a cat – even fiftysomething guys like me can jump when push comes to skunk – and we dive into the car.

After a few minutes Jack sweeps the telescope-centered encampment with the flashlight beam. The skunk appears to have departed, so we pile out.

The moon is rising now, and its glow faintly paints the field. It would be obliterating stars too – if any were left. But the mackerel clouds have taken over.

“Well,” Jack says philosophically, “we saw quite a few stars. And the galaxy.”

“The moonlight would have dimmed Mars tonight anyway.”

We look at the cloud-stricken sky. This is Maine, after all. Even when we visited an expert, Peter Lord, and his souped-up five-inch refractor on Mount Desert Island which has some of the least light-polluted skies in America, the clouds still got between us and the stars.

“Well, let’s pack up.”

The telescope is never a problem on the way home. You pay your earthly dues, and after that the sky’s the limit.

## STARLIGHT

### I. *Orientation*

The key to stargazing is points of orientation.

In the beginning, like for all beginnings, you take the simple points first, which in the case of stargazing is simply the brightest stars. There are two ways to use the bright stars, and like practically everything else in the universe, the two ways tend to merge: orientation by individual star and orientation by constellation. I mean, some stars are very bright and easy to spot, and some constellations are very prominent to the eye.

For example, in a clear field looking north at our latitudes (44.67 degrees north here in Troy), most people can pick out the bowl and handle of the Big Dipper without much help. Once you've got it, you can never miss it again. And a nice advantage to it is that in our part of the world it's always up there; it never sets, it just whirls around and around night after night, sort of comforting in a way.

But anyway, once you have the Big Dipper (or Ursa Major, the Great Bear) for a point of orientation, the geography of the whole northern sky opens up. The two outer stars of the bowl make a line pointing northward at a fairly bright star – this is Polaris, the North Star. From Polaris you can trace a somewhat fainter curve of stars around to another smaller dipper – the Little Dipper (Ursa Minor, the Little Bear). And in the Big Dipper's handle, the two end stars point roughly toward the fourth-brightest star in the sky, reddish Arcturus.

These are all, with a little patience and focus, easy to find, and you can never get lost in the northern sky again. That feels like it could come in pretty handy at some point, though I'm not sure when, exactly.

There are clear points of orientation in other parts of the sky in different seasons, too. In summer an easily spotted constellation is the Northern Cross, or Cygnus, the Swan. It's not as distinct as the Big Dipper because there are more visible stars in its vicinity, but once your eye lights on it, it sticks in your memory because its five stars are in the exact proportion of a cross, or a flying swan or goose. To the side of the swan's head is the fifth-brightest star we see, Vega. A couple of skips farther on the other side of the swan's head is another bright star, Altair. On August and September nights Altair is near the southwest horizon in the constellation Aquila, the Eagle, whose four brightest stars, when your eye catches them, look like a flattened diamond.

In September and October, in the east just after sunset you'll see four fairly bright stars in a distinct box shape, with few other stars visible among them; this is the Square of Pegasus. If you scan to your left a little bit, your eye will enter a star field, and in it are five quite bright ones in a lopsided W – this is Cassiopeia.

In winter the most striking shape in the southern evening sky is Orion, with his three-star belt and a sword hanging vaguely off it. Two bright stars above and below are at his head, or more precisely his shoulder (reddish-colored Betelgeuse), and foot (cold, bluish Rigel). At his heel is the brightest star in the sky that's not the Sun, Sirius, the Dog Star in the shoulder of Canis Major, the Big Dog, bounding along behind the hunter.

Now these are just beginnings. These bright stars and constellations are like outposts in space from where you can navigate further out. This is not like a video game. But with patience and repetition (they're there every clear night, year after year), you'll see less obvious constellations start to emerge from the welter of lights, like Hercules, which is a lopsided box between Ursa Major and Vega with four stars like appendages shooting off it. Nearby is a crownlike semicircle of stars called Corona Borealis. Between the Square of Pegasus and Cassiopeia is Andromeda, where if you're patient and can use binoculars, on clear nights you can pick up a smudge of light that is actually a galaxy, M31, 2.5 million light-years away.

These stars and constellations are bright points of orientation on your maps of the stupendous elsewhere that will eventually, if you let them, burn themselves into your mind. That could come in handy sometime. I'm not exactly sure how yet.

## II. ***Information***

Just a few points of orientation are enough to find your bearings among the roughly six thousand stars your eye can pick out in a black sky, clear of city lights. About three hundred of the brighter ones have names, like Polaris, Sirius and Vega. The rest are known to astronomers by numbers.

The names by and large are ancient, given mainly by Arab astronomers, and also Greeks and Romans. Altair, for example, which you can see on summer evenings, is called after the tag end of the Arabic phrase al-Nasr al-Tair, the flying eagle, which applied to the whole constellation we call Aquila, the Latin for eagle.

The first complete atlas of the sky that systematically identified the bright stars was the *Uranometria* published in 1603, in which Johann Bayer assigned Greek letters to the stars in each constellation. Altair is Alpha ($\alpha$) Aquila because it's the brightest star in the constellation. In the 1700s John Flamsteed used the brighter stars' positions, rather than their brightness, to assign numbers.

The Bayer and Flamsteed designations are still basic identifiers today. And millions that were too faint for the early modern astronomers to spot, but that can be seen through our much more powerful telescopes, are now cataloged by number in compendiums like the *Yale Bright Star Catalogue*, the *Smithsonian Astrophysical Observatory Star Catalog*, and the *Henry Draper Catalogue*.

Hundreds of billions more in our galaxy are unnamed. And as if those 400 billion or so in our cozy little vicinity, just a hundred-thousand light-years across, weren't enough, some astronomers zero in on individual stars in other galaxies, if you can believe it, which even in the most powerful telescopes are just patches and blobs of light.

An odd thing that happens after a few excursions among just the visible six thousand is that you begin to notice not all stars are alike. They differ the way snowflakes differ, or human fingerprints or irises. Each one has its own sort of character or personality. The astronomers from ancient times to now have spent a lot of time sorting out these differences, although nowadays they generally do not use words like "personality" to describe a star's qualities. They use phrases such as "spectral class," "proper motion," "luminosity" and "magnitude."

You see just by looking at them, for example, that Vega is brighter than Polaris. Polaris is brighter than Thuban, which is just a skip from the edge of the bowl of the Little Dipper. The scale for describing the brightness of stars, which has been in use pretty much intact since ancient times, is called "magnitude." The brighter a star appears, the lower its magnitude. (This seems counterintuitive, in a way, because you'd think the brighter the star, the higher its magnitude number would be. But the originators of the system centuries ago referred to the brightest stars as being of the first magnitude, the next brightest stars were of the second magnitude, and so on. So when numbers started being assigned, 1 was brightest, 2 was less bright, 3 less bright still, and so on into the telescope-only ranges, 7, 8, 9 and on.) So the brightest star in the sky, Sirius, has a magnitude of –1.46. Vega, the fifth-brightest star in the sky, has a magnitude of .03. Polaris has a magnitude of 2.02, Thuban 3.65. Just about anybody can learn to estimate star magnitudes by eye, as it were, and binoculars.

Your eye can also pick up star colors. Betelgeuse atop Orion's belt is noticeably red, and so is Arcturus. Rigel has a bluish tinge. Sirius seems to sparkle iridescently.

Color and brightness alone are enough to make meaningful distinctions, as the naked-eye astronomers (all of them before about 1610, when Galileo turned one of the first magnifying lenses on the sky) well knew and depicted. And the visible stars travel their own paths both nightly and yearly across the sky, adding to their individuality in a way. In ancient times Sirius' reappearance at dawn in spring signaled it was time to plant the year's crops.

Modern astronomers, of course, have discovered a lot more star distinctions. As telescopes grew more powerful, the measurements of star positions became more precise, and it was noticed that the stars, while they seem fixed in place, are not: Each star is itself a traveler. It has a "radial velocity," which is a measure of its speed toward or away from us here on Earth, and a "proper motion," which is a measure of the star's apparent annual change of position. All the stars are orbiting around the center of the galaxy; our solar system is thought to make one orbit in about 220 million to 250 million years.

These measurements are calculated from kaleidoscopic amounts of detail gathered from starlight, which is detectable electromagnetic energy. The fundamental method is to focus the light of a single star into a spectrometer, which splits the light into its component colors. To vastly oversimplify, the astronomers have figured out what the arrangements and intensities of the colors indicate about a star's age, chemical makeup, absolute magnitude as opposed to the apparent magnitude we perceive here on Earth, distance, output of energy, direction of travel, and so on, including whether it has any close companion stars or planets.

Our own Sun is a star of medium size and brightness, as stars go, classified as a dwarf star of spectral class G2. Because we are so close to it, the Sun's apparent magnitude is figured at –26.7, far too bright to look at directly; its absolute magnitude is 4.83. Betelgeuse is an M1 red giant, 160 million times the Sun's volume (though just twenty times the sun's mass), with an absolute magnitude of –5.6. Rigel is a B8 white supergiant with an absolute magnitude of –7.1.

You could spend a lifetime sorting out information on one star at a time, synthesizing the astronomers' facts with your own night vision, and probably not make your way through all of the visible six thousand. Because what happens, at points, is that particular stars get your attention and you return to them, over and over. The more you look at them, and the more you read the starlight data, the more you see. And don't see, as it were, through your glass, darkly.

### III. ***Hallucination***

Unlike professional astronomers, who are trained to separate their own experiences from the objects they're looking at, I pay attention to flashes of light generated by malfunctions in my brain. In other words, I find the dance of glittering lights in the peripheral vision of my left eye during an ocular migraine fascinating, even though doctors have explained to me it's only a misbehavior of my retina.

So the essays in this book are not rocket science. And actually, from the point of view of the astronomy department, they are not science at all. From the point of view of science, which categorizes this sort of thing as a medical issue, some of these essays at least are expressions of conscious perceptions with no external material stimulus. In other words, hallucinations. Hallucinations prompt debates in the medical profession because, while some stimulus-free sensory experiences are quite benign, others are quite distressing and indicate possible dissociative disorders or even psychosis, which speaking colloquially refers to a sharp detachment from reality. Or reality as most people experience it, anyway.

Hallucinations, though, are motes to trouble the scientific mind because in certain modes they are pretty clearly not pathological. They are thought by some scientists to occur during the process of "reality monitoring" (which refers to your constant process of distinguishing between what's happening out there from what's happening in here), where disruptions in perception, which happen all the time, are repaired for continuity's sake by your brain. This seems to me and some other scientists an incomplete description of the boundaries between internal and external reality, which the more you explore them are not sharp.

Beyond simple disruptions in perception, there are states of sensory override, or absorption, as it's called in some scientific literature, where the activities of the mind override actual sensory experience and become experience itself. They have a long, complex, carefully documented history going back thousands of years in a variety of religions. In some ways, the religious meditative practices that cultivate sensory override are a kind of highly refined phenomenology of the mind. In any phenomenological approach to reality, you account for all the phenomena available in trying to figure out what is happening. No phenomenon is excluded, including visions seen with no external stimulus. Most hard-core empirical scientists have stopped reading by now, though, because I'm saying my descriptions of reality preserve phenomena that astronomers would by and large dismiss as hallucinatory biochemical side-effects. In other words, crazy, if taken seriously.

The trouble is, if you pay attention closely enough, over long enough periods of time, to glints of light and to dreams, reality really starts to take different shapes from what strict empirical science describes. Especially when exposed to starlight.

*This is your brain.*

To think about stars, astronomers use instrumentation to break beams of light into parts, then measure, classify and catalog the data and describe how the physical and chemical details integrate with each other. Starlight, in other words, carries information into telescopes, spectrometers and other instruments, and the astronomers process it. Most of this gathering and processing is done with computers nowadays.

On the other hand, when you look up at the sky on a clear night, that same starlight, with the same information, goes directly into your own eye but your brain processes it entirely differently from the scientists and their instruments. Light enters your cornea and is refracted through your pupil to a lens, which in turn refracts the light onto your retina, in the back of which are photoreceptor cells that absorb photons. In this layer of rod and cone cells, known also as Jacob's membrane, cones deal principally with colors in bright light, while rods are a hundred times more sensitive and are the primary source of peripheral and night light information, meaning maybe that they specialize in starlight. They transmit signals to ganglion cells of the two optic nerves, which meet at the optic chiasma and cross, so the left side of your brain processes signals from the right, and the right side processes signals from the left. More lightninglike processing lands the signals at the visual cortex at the back of the brain. There, with still more complex chemical processing, you become aware of the shapes and motions signaled by the photons that entered the pupils of your eyes.

For the most part, you have no idea what your brain is doing with those infusions of light. And no one knows why or how your brain generates images with no photons involved while you are sleeping.

*This is your brain on starlight.*

The biochemical processes produce an image of a star in your mind. For the most part, the only directly associated things you experience are: 1) the image of the star, and 2) a feeling of beauty. To virtually all human beings, it seems, the stars are beautiful. That feeling is produced somehow when starlight penetrates your eye and is processed inside your brain.

If you stop in the driveway and let the starlight work on your eyes for more than a few seconds, your brain starts to produce not only an apprehension of beauty, but it also starts to break that apprehension into further feelings such as awe, then eternality, and an inspiring and eventually frightening or comforting sense of a vast unknown. The night sky begins, in just a little while, to feel like a tremendous dream world of untold powers – explosive, burning, enormous – and of glories and potentials, and for some people at least, a sense of intelligence. No one knows why or how your brain generates these feelings while you are yet fully awake.

Some people seem to have more refined inner-separating instrumentation than others, and an interesting facet of this kind of experience is that you can usually shut it off anytime you choose. You can just go in the house. Or you can say to yourself: It's light and dark playing tricks with my rods and cones. Usually, for adults who have learned to use words to cushion reality (what Robert Graves called "a cool web of language"), a prayerish sentence like that is enough to dissolve the spell. Back to reality.

But a troubling aspect of this return to reality is that even some bare astrophysical facts, from a certain frame of reference, produce similar dreamlike effects: Some globular clusters appear to be older than the estimated age of the universe; space-time as we know it vanishes inside black holes; it is virtually certain there is a fifth dimension unexperienced by us; ninety-six percent of the matter in the universe has not been detected. The astronomers are pretty sure that dark matter is there, in equation and imagination, but it has never been seen. And it's so huge there are no instruments or words to bring it into focus. It's less like a scientific datum, in actual experience, than it is like a disturbing dream, waking up unable to remember it very clearly, but having an inarticulable feeling of its meaning. You don't know what it means, but the feeling is quite vast, powerful and disturbing.

Dreams are a kind of peripheral vision. You don't see much unless you watch for it. And even when you start picking up activities of light in the corner of one cornea or the other, you cannot look at it directly or it vanishes, like an electron identifiable by its velocity but lost by locale. You don’t know where it is, or what it means, but you know it’s there.

Years ago, on about the fourth or fifth late-summer night in a row I’d spent in a field peering through a telescope with a sort of transfixion at the star Algol, I suddenly, inexplicably felt frightened. The star itself, whose name is Arabic for the Demon’s Head, or the Ghoul, had wavered in magnitude, as it scientifically does, and on that night unsettled me. Wild sounds I had never heard before leaked out of the woods on the edge of the field. The star seemed to flicker. Stuck in a nightmare of some kind, I packed up my gear and went home. Went in the house, that is.

That’s one kind of uncertainty. A more common hallucinatory experience arises for a great many people when you get the star Sirius in your line of sight on deep cold January nights. It glints red, blue, green and white. It is only 8.65 light-years from us, far away in miles yet one of the closest stars to us. It sparkles, there, and will render a kind of hypnosis on you if you’re not careful with your brain-chemical sentences.

I’ve seen stranger things than Sirius and Algol, equally concrete to my eye.

A few summers ago my son Jack and I were on the deck looking through binoculars at a slightly hazy evening sky when we noticed a pencil-thin band of light from horizon to tree-lined horizon, south to north. It might have been a searchlight except that it was so thin, it was utterly motionless, and it spanned the whole dome of the sky, not to mention we are miles from anyplace that might use a searchlight. It remained there for half an hour or so, until thin overcast slowly obscured it. Afterward I described it to several astronomers and atmospherics scientists, but none of them had any clue what it could have been.

A strange perception took shape on my visual cortex during several summers in the mid-2000s when, in all kinds of night conditions, from dewy to dry, warm to chill, networks and webs of steam would filter up apparently from my breath before the star Altair. When I blinked and turned my gaze on a different star, like Vega or Deneb, my vision cleared. This happened many times over several summers, then one summer, like an allergy, winked out.

Late one recent winter, Jupiter and Venus danced up close to each other, so bright there that even people who never look up looked up and were struck by the brightshining, burning beauty. Jupiter at brightest was at magnitude –2.2 and Venus at –4.2, and twice the waxing Moon joined them. So vivid were these feelings of beauty in people's minds that news reports called attention to them. There were several nights in this apparition of planets when my eyes apprehended in the dazzling spokes around Venus a point of light just to its north, as though it had a moon. It was as distinct as objects in peripheral vision are distinct.

The harder I looked, with naked eye, over several clear nights, the more pronounced it seemed. Was it a nearby bright star almost occulted by Venus? At the apparent separation, that would have to be a very bright star to shine through the radiations of planetlight caused by the Earth's atmosphere. My star charts showed one star in that position, but of magnitude 7.2, too dim to see without a glass. The first night I fantasized it might be a serendipitous nova. But no news reports appeared, which certainly would exclaim the cosmic coincidence. Now this disturbance in my night vision started to seem weirdly similar to the Comet Hale-Bopp disturbance of 1997 which ended badly, partly on the authority of an otherwise credible university professor: Dr. Courtney Brown claimed he had remote-viewed a UFO accompanying the comet, which was already rumored on the Internet and talk radio to have an alien spacecraft accompanying it, and this fed the belief of the millennial Heaven's Gate cult that Comet Hale-Bopp was a sign the time had come for them to leave their physical bodies; thirty-nine of them together committed suicide. In my binoculars, though, the

Venusian radiations disappeared and so did the orb absorbed in my eye. I could only think my mind was alloying Venuslight into a kind of involuntary, persistent waking dream of a companion.

I'm just reporting phenomena I saw with my own eyes. I make no claim one way or another about my sanity. As far as I can tell there is no science to explain with any certainty these quirks of my rods and cones, and so, since they actually happened, it seems best to treat them like dreams, whose empirical science no one understands and yet whose sense of meaning most people admit is real. They are a periphery of reality. Or is the periphery, like a universe on a membrane, the center?

### *IV.* ***Illumination***

Where imagination ends and hallucination begins, no one can say for sure. And where hallucination ends and illumination begins is even more uncertain. Among the phenomena described by science, at least.

Many summer and early fall nights I've stood in the yard with binoculars or the telescope looking at Hercules' shoulder. Orienting your view from Vega, which is almost directly overhead on August evenings, and then turning a bit to the right, your eye can pick up an Arkansas-shaped trapezoid of four stars which is the Keystone of Hercules. In myth imagery it's his torso, basically upside down, or head over heels from our vantage point. A fairly bright star extends out from each of the four joints of the Keystone, and off the lower left, or southmost corner is Sarin, Delta (δ) Herculis, a 3.2 magnitude star about seventy-four light-years from us. Off the lower right corner is Kornephoros, Beta (β) Herculis.

Sarin is an A3 blue-white subgiant, but hidden inside that fact is another fact: Sarin is not one subgiant star at all, but two stars so closely in line with each other that only equations based on light variations reveal their separation. They do not appear to be gravitationally connected, but separate stars coincidentally in our line of sight.

I don't remember the origin of my fascination for Sarin. I plant my little 4.5-inch Newtonian reflector on the deck and point it out there, more or less whimsically nowadays. In my earlier, Algol-watching days my excursions were planned and systematic, with star maps, flashlights and cardinal alignments, in the tradition of old-time serious stargazers. Now I just wait for planets and glints of light to strike. Astronomers get their knowledge along projected lines of logic; poets get theirs from the sky, and as it happens in and out of books, to paraphrase Robert Frost. Probably that's how I lit on Sarin.

Anyway I have been looking at it casually and intently, though not cavalierly, for years. It is my chief point of orientation in the summer sky. Its light stirs comfort, and disquiet.

When I look directly at it, I can't see it. It's as if some macro-manifestation of the uncertainty principle is at work. When I stop in the driveway late at night to look, it vanishes in my eyes' natural blind spot. This doesn't happen with all the stars, only a handful, and most of those inhabit a kind of winking existence on my retina until I direct my line of sight just to their sides. Sarin, however, disappears completely. To see it, I have to look at it peripherally. The further I avert my gaze, the more I see, but the less directly the light strikes my eye. It's a dusty-looking, very pale yellowish fire. In binoculars I see it directly and it takes on the gemlike quality of all stars seen through a lens, a cold, dusty white light with some fantasy of blue. In the telescope, it becomes a hard, white, lonely crystal.

That's in summer. By nightfall in late October it has dropped behind my western tree line. So all winter I wait for it to reappear. By June evenings it's high enough in the east to see over my firs, and it beckons to me all summer long. Every clear night I take a look at it, either sidelong or through a glass. That aloof, dusty shroud in defiance of my direct gaze has somehow transformed Sarin into an uneasy feeling of distant risk or unknown, or of vague peril, while at the same time it's the home base of my own private sky lore. The rest of the known sky maps outward from Sarin, to my mind.

And yet, it has no myth. Beyond marking Hercules' right shoulder, the origin of its name is unknown. The word "Sarin," as far as the star etymologists can figure, first turned up in the *Atlas Coeli Skalnate Pleso*, which was created in the mid-twentieth century by the Czech astronomer Antonin Becvar and first published in the United States in 1949. But where Becvar got it (along with eleven other strange, untraceable names), no one knows. The Skalnate Pleso is an astronomical observatory in Slovakia where Becvar worked, and the phrase, which sounds like something out of a science fiction novel, means "rocky lake." Your imagination of course can run wild with fantasies on Becvar's possible channels of information, given what regular exposure to starlight can do to your mind. But some anchors to Earth are necessary, and the black wastes of the evening sky are pure formless terror unless you give them some kind of name. So in Sarin's case, Becvar threw out an anchor. If we could not name things, we'd go mad and die, I think. We are compelled to orient ourselves. Why, exactly, I have no clue.

There are no direct clues either to why Sarin has appeared to me in dreams with dazzling brightness, yet dusty-seeming. I've seen it up close – what in normal space-time might be the equivalent of a billion miles or so – as a bright, white, steady combustion partly obscured by a disk of dust.

Such a disk has not been detected by astronomers. It's a dream I had, of an encircling cloud with a rolling cumulus-like shape, real enough in mind to correspond to my inability to see the star directly from Earth. From those clouds of unknowing has arisen a sense of stern guardianship or protectorship. And moreover, from out of the veils, at some uncertain time, emerged a muselike conjunction of Sarinlight to art, the fashioning of language, and divine afflatus. I look up there sidelong summer nights and light angles in across the double slits of my pupils and into my iris, combusts there on the back of my retina and the sense of a breathing kinship with the light itself forms. You can understand this in two ways – by astronomy or by dream – and whichever one you choose will rough-hew the meaning you make of it.

My images of Sarin, in the yard, in sleep and in memory, have a weird, dreamlike quality. The hard, cold starlight in the yard is etched as permanently and clearly on the screen of my memory as sequences of events in sleep. The more directly you try to remember, the less accessible are the details.

I wonder what it's like up there in the vicinity of Sarin. Since at least Plato's time, and no doubt much longer, people's imaginations have been gripped by the sense that our origins are in the stars. Plato says in the *Timaeus* that the fixed stars were created as divine, eternal beings. Next the sentient beings were created, and each soul was assigned to a star. (The data of the last fifty years verify there are plenty of stars to go around.) Sentient beings, says the *Timaeus*, are in a process of being born into material bodies. Those who live well return to their stars of origin. Those who do not live well suffer – well, a return to Earth.

It's hard to believe, as Lewis Thomas the biologist observed the latter part of last century, that a structure as complex as consciousness would simply dissolve into nothing, as though it had never existed. Nature just does not abandon complex structures like that. It tends to transform them, like ice crystals transforming into water or supernova jetsam transforming into stars. Or lights in the brain transforming into dreams.

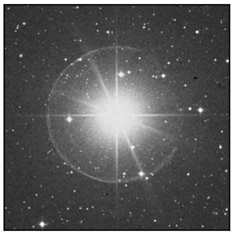
"The sky is just the same as the Earth, only up above, and older," a Micmac storyteller around 1900 observed for possibly the ten-thousandth time since one of his ancestors, presumably with firsthand dream knowledge, originally pointed it out. According to some astrobiologists, comets may have seeded

Earth with the chemicals of life. Either way, the stars look like our first home.

You cannot look directly at the universe in its immensity. Most of what is happening out among the stars is completely and utterly unseen by human beings. The only clues come from starlight. Once it hits the back of your retina and generates signals, you have to wonder what they are and try to place them, somehow. As spectral readings and then inferences about the readings, or as dreams and then interpretations of the dreams. Something tells me there is a conflation of the two both far out and in deep.

Where science leaves off, metaphysics begins. Contrary to current conventional wisdom, metaphysics – roughly, the mapping of the immaterial cosmos – is not the indulgence of speculative fantasy. It is the description of phenomena and structures noticed to have persistent coherence in the mind. It places phenomena of the mind, parallel to the way spectral readings place the phenomena of starlight.

We can’t see out too far, when we look at the night sky, or look in too deep when we dream, but when did that ever stop anybody from marking out points of orientation in the detectable geography? I wonder if I will get back to Sarin, and what it will look like, and what its name will be should I get there.



*Sarin*

## REGULUS

I remember looking up one night decades ago through broken clouds, with icy snow underfoot, and feeling afraid. The kind of fear that creeps along the back of your neck and clogs your throat.

It was a star, one pin of light among thousands, unimaginably far away. Huge distances are chilling. But this time its photons, launched from its burning surface centuries before, seared my mind's eye and the star sort of awoke. It scared the hell out of me.

It's sort of reckless to recount a story like this in public. It could provoke mean laughter, or worse, indifference. A grown (and young) man "afraid" of a star countlessly far away?

It was a long time ago. I don't know what star it was. Over the decades I built up some objective, sky-chart-type knowledge. But that first moment of fear was not the last. And what's more, I was not the first to feel it – and hardly the last, I imagine, though our experience of the natural world is very different here in the twenty-first century from what it used to be.

One spring Regulus, the brightest star in Leo, the lion, got my attention. You can see Leo prominently late in the evening at this time of year slightly south of overhead – five fairly bright stars in roughly the shape of Virginia. Regulus is the star at the lower right. It's about seventy-nine light-years away and shines with a luminosity three hundred and sixty times greater than the Sun, and is three or four times as big. It has an unusual sheen, or luster. That luster can work strange events on your mind's eye. I didn't spend a lot of nights on Regulus. It got uncomfortable quickly. Sort of overbearing, in a weird way.

I don't know why I think you're supposed to understand the words "uncomfortable" or "overbearing." It's just a star. But there it is. And apparently I was not the first to feel it.

When I stopped looking and started reading about it, I discovered that the name Regulus, a form of the Latin for “king,” was given by Copernicus in the 1500s, and is just the most recent in a long line of names marking the star as a ruler. The Romans called it Regia, “royal one.” The Arabs called it Malikiyy, “kingly one,” a word translated from a Greek link to an ancient king, Amagalaros. The Greeks also called it Basilicos, “regal.”

Persians called it Miyan, “central one.” Earlier, Babylonians called it Sharru, “the king,” and Akkadians called it Amil-gal-ur, “king of the celestial sphere.” This is going back more than 3,000 years. Hindus called it Magha, “mighty.” Some Chinese astronomers called the constellation the Yellow Dragon – in China the dragon has many of the same connotations of regality the lion has for us.

Here in the scientific age, it’s taken for granted that the original star names were whimsies (which ironically is how they tend to arise now – by a dust cloud’s shape, or after a TV character) because the stargazers, being ignorant of scientific facts, could only concoct fantasy explanations: Mars was named after the war god because it’s red, like blood, and blood is spilled in war.

Were they really that innocently hasty? Those ancient astronomers were no less intelligent and no less diligent than our guys with telescopes, calculus and relativity. But they were not seeking the same kind of knowledge modern astronomers seek. They not only tracked Regulus’ path in the zodiac, they also paid attention to the particular kind of awe its luster worked on their minds’ eye. An intuition of “royal” developed there repeatedly, for millennia, before anyone had a clue there was any such distance as seventy-nine light-years. The star names were not whims but expressions of certain kinds of highly refined knowledge that was not empirical. In the ancient experience, the stars were forces, detectable through fear, that we are obliged to pay respect to.

The ancients would no doubt be astounded to know what we know. And I have a feeling we would be astounded, or terrified, to find out what they knew.

## THUBAN

In November the great weight of winter starts bearing down on us again. For younger readers this will sound like little more than an old guy's grouchy personal mythology stinging their ears. But the more years you've lived through the apparently interminable stretch from December to March, the more the cold seems to peer with dragon eyes over the northern horizon. I mean, for months it will be too much trouble to clamber over snowdrifts to get to the Shed and its creaking floorboards only to forget what brought me there in the first place.

In a way the iciness to come lives in the idea of *north*. It's where winter comes from, and certain stars reflect it all year round, especially Polaris, which marks almost exactly true north. Even in summer it looks bluish-white and icy itself up there. Who knows which came first, the cold white star or the cold white apprehension of inevitable winter.

Anyway it doesn't matter because a lot of northern stars will do for the idea of cold. Ursa Major – the Great Bear, or the Big Dipper – wheels around the pole all year, never setting, in tandem with Ursa Minor, the Little Dipper, where Polaris is the tip of the handle. They shine brightest on cold nights, and have done so for millennia and longer. Our word "arctic" derives from the ancient Greek word αρκτοσ, meaning bear and associated, at some forgotten time in antiquity, with Polaris, the central axis around which the whole sky turns.

The central axis for now, I mean. Similar to the way the seasons eternally turn, the stars also turn, not just nightly from east to west as the Earth rotates, and yearly, as the Earth revolves around the Sun, but also in a much longer cycle where the northern (and southern) polar stars travel a great circle. Polaris, in other words, was not always the pole star. About twenty-five hundred years ago, Kochab, one of the bright stars in the Little Dipper's bowl, was nearer true north than Polaris.

*True north*, in my parlance, is at the top of an imaginary line or axis running through the Earth perpendicular to the Sun. The Earth's spin, however, is not exactly along that axis. It's tilted about 23.5 degrees. In other words, the North Pole does not point at true north. It's 23.5 degrees off the perpendicular to the Sun. It's this tilt that gives rise to the seasons, as our hemisphere tips into the Sun's warming rays in summer, and away from them in winter.

And not only is the Earth tilted, but it's slowly wobbling in its spin, like a gyroscope knocked off its up-and-down balance. The wobble is called precession. One full wobble takes a bit less than twenty-six thousand years. This means the northern stars appear, over these millennia, to make a great circle. So every few thousand years a different star marks true north.

In our time, Polaris is within a degree or so of north. But around 500 B.C. (twenty-five hundred years ago), Kochab was nearer north. Around 3000 B.C. (five thousand years ago) Thuban, in the constellation Draco, the Dragon, was the pole star. About a thousand years from now, the star Alrai in the constellation Cepheus will mark true north. In 14000 A.D., Vega will be within about 5 degrees of north. In 27800 A.D., after one full circuit of the wobble, Polaris will return to be the North Star.

This has of course been going on for countless millions of years, the result of torque from the Sun's and Moon's gravitation on Earth's bulging equator. How long ago humans first noticed the great slow star-circle, forgot it, then relearned it, no one knows. The entryway of the Egyptian Great Pyramid, which seems to have been built around 2800 B.C., aims exactly north, which in those days would have been marked by Thuban. This is not evidence the Egyptians knew about the great year, necessarily. But records or handed-down memories from that time indicating the positions of stars would, after a few hundred years, reveal the stars were changing position in slow circular motion. Plato in about 370 B.C. referred to the great year, and some scholars think mythological stories contain coded information about the stars and the great year and more. Stories that could be fifty thousand years old, some of which are still remembered today but whose secret codes are forgotten. It may have been foreseen that Thuban ages hence would return to north.

Thuban is a strange star, to my mind. It's designated as the Alpha (α) star of Draco even though it's not the brightest in that constellation. Its name is Arabic for serpent, which makes sense, but it came by it through repeated medieval copying mistakes from the Arabic phrase "r'as al-tinnin," the serpent's head. It's classified as a white giant, a type of star rarely seen. It's cold-looking. Distant-seeming even beyond its relative faintness near the bowl of the Little Dipper, like an echo of something, a cycle of time so slow it was forgotten. It's lean and hungry, and projects a boreal chill even in summer.

Or am I projecting my own chill? I don't know. I can't even remember how I got here. I only know it's starting to be cold again, the trees and branches will be cracking and moonlight soon will refract through icicles and frost, while Thuban and Polaris watch.

No one knows the exact relationship of the human imagination to the physical universe. In science, the nearest thing to exactness on this problem is the complementarity principle of Neils Bohr's quantum physics. In the 1930s Bohr took the empirical findings of quantum experiments to mean that no experiment happens independently of the observer or the observing system. The impossible situation, for example, of light behaving simultaneously as a wave and a particle is due at least in part to the choices of the observer of the light. In other words, an experiment consists of the object of the experiment, the equipment of the experiment, and the observer of the experiment, and all three together act indivisibly. The act of watching an experiment changes its outcome.[1]

Not being a physicist or astronomer, I do not pretend to understand what this means in a technical sense. I do understand that it is a spooky idea, however. If it's true, it suggests that every action, every thought, every attitude influences the events and shape of the universe. In the plainest moral terms, it means that every human mind is responsible for an element of the goings-on in reality.

Then the question becomes: How much responsibility does each of us bear for the condition of the universe at any particular moment? This is difficult partly because no one knows exactly what the universe is or does or means. Some philosophies argue that no one knows for certain if the physical universe exists at all. For Hindus the whole material world is an illusion, *maya*. This idea squares fairly well with the idea that $E = mc^2$, which describes physical matter as a configuration of energy. Of course, Hindus do not mean that at all. They mean that the material world is of no more significance than a few stray marks on a piece of paper. All the rest of reality is beyond those marks. Einstein, so far as I can tell, never meant that.

Somehow, though, there is the sense that, however illusory the physical universe is, either in a scientific or a religious sense, it is at least real to us. The pain that comes to us from a bee sting or a broken leg or an emotional separation or the death of a loved one is real pain. The pleasures of sex or supper or laughter or love are real experiences. And it seems clear that some of the pain and pleasure comes to us from outside ourselves, and some of it comes from inside ourselves. Each human being is a living quantum experiment: the object of the experiment, the observer of the experiment, and the equipment of the experiment all bound up in one.

If this is true, then changing your view of yourself, as object, must mean changing the various outcomes of your experiment, or experience, as the case may be. You might for example stop imagining yourself as a material entity and begin imagining yourself as a spiritual entity. From this perspective you might cease to think of your body as "containing" your spirit or soul or consciousness, and begin to think of your soul as containing your body – your soul being prior to your body, it would naturally give rise to or contain your body, rather than the other way around. This observational shift would change the experiment from Einstein's proposition that $E = mc^2$, all matter being a reservoir of stupendous energy, to the proposition that your body is an illusion, all energy or (to change terms as well as perspective) soul being a stupendous reservoir of matter. They are the same experiment, but they describe different kinds of reality. Believing your soul to be real, and your body illusory, you would have much less care for your supper than you would believing your body real and your soul illusory.

Reality in this sense inheres in an act of creation. If you can successfully and authentically change your perspective on reality, and if you indeed complementarily change the outcome of events, and if there is indeed some sort of reality outside our own bodies and minds, then the three propositions together suggest that a human being is at least partially the maker of reality.

I say "partially" because the reality outside our own bodies seems also to have been generated. But not, it seems, by human beings. The anthropic principle of physics posits that the universe is the way it is because we are here to see it, implying that all the numbers and "laws" of physics are here by design, but not human design. It's difficult to see, given our understanding of time and our place in it, how a human mind could have generated the Big Bang. If the universe did originate some 13.7 billion Earth-years ago in an ineffably enormous explosion, a human mind did not engender that explosion because there was nowhere for a human mind to stand prior to or apart from the explosion. Human beings could not observe the creation of the universe. The human mind is not the maker, let's say, but a maker, one creative power among many: among whatever intelligences encode genetic material in DNA, or spin up stars in nebulae of gas and dust, or cumulate galaxies from ripples in the cosmic radiation.

The entire universe, including its genesis, begins to look like a colossal act of imagination, the cosmic counterpart of the human imagination. If the imagination of the universe is capable of engendering itself, then is the human imagination, equally, capable of self-creation? Does the human imagination, as part of the living quantum experiment of object, observer and equipment, shape its own life? Wallace Stevens thought so:

> It is not in the premise that reality
> Is a solid. It may be a shade that traverses
> A dust, a force that traverses a shade.

* * *

The star Algol is in part a generation of the strange intelligence of the cosmos, and in part a generation of the human mind. It's a point of light visible from central Maine in the northeastern sky on autumn evenings when the frost is about to settle and the corn stalks are going brown. Objectively speaking Algol is an average star about seventy-two light-years distant from us. It appears to be three to four times as massive as the Sun. It is one of the sixty or so brightest stars in the sky, having a visual magnitude (a brightness) of about 2.1. (The lower the number, the brighter; the brightest star in the sky is Sirius, with a visual magnitude of –1.5.)

This is not all, however. It grows dimmer and brighter in roughly three-day cycles. This occurs because Algol is an "eclipsing binary," which means it is not one star at all, but two stars orbiting each other. The description above, except for the magnitude, covers the larger, brighter of the pair. When the brighter star faces us, then Algol appears brighter to us, but when the darker of the two stars passes in front of its companion – for about ten hours every three days or so – then Algol grows noticeably dimmer.

I have observed this brightening and dimming myself, I think. There is some reason for uncertainty on my part because star magnitudes are frequently and sincerely affected by the weather in my part of the world. In central Maine it's too cloudy four nights out of seven to bother looking up, and even on clear nights high scud or high vaporous humidity interferes with the passage of starlight, and calls into question the verifiable scientific brightness of the stars. The seeing is more accurate in a desert because the air is so dry and clear. There is no desert here in Maine.

Algol is well-seen from Maine, however, because the farther north you go in autumn, the sooner darkness falls. Beginning in late August, Algol is visible rising over the eastern tree line by about 10:30. By the same time in early October it's high enough in the sky to watch with clear trepidation, located as it is in the constellation Perseus. Apart from the act of scientific imagination which discovered and recorded Algol's distance, mass and visual magnitude, the word "constellation" is the first indication that we are on the dusty outskirts of objective speaking and moving into the damp frontiers of the human imagination.

Of course, many citizens of the scientific twentieth century create this metaphor backwards. They say that the objective facts – the gist of science – are on the frontier of imaginative possibility and the constellations are from the faded, outdated, used-up territory of antiquity. But the constellations imply the creative part of the human mind, which I'm trying to speak of here, and the objective facts (however radical and innovative the scientific method still seems to some people) gleaned by astronomers imply only the attempt to categorize observational data, not yet to make anything that feels like the truth flower from it. Constellations are generations of the human mind. They are bunches of stars grouped together by ancient astronomers who knew nothing about absolute magnitude or thermonuclear combustion or binary stars or even about stars at all, in the sense we think of stars: They believed the stars were literal gods. The groupings of the ancients, however, were powerful, if immensely practical, acts of imagination. Stargazers still use them to locate ourselves.

Perseus is a group of stars just east of another familiar northern group called Cassiopeia. Perseus's brighter stars make a kind of crooked leg under Cassiopeia, and about 2 degrees east of one crook sits Algol, actually the second-brightest star in the group. According to the imagination of the ancients, Perseus tracked down the Gorgon Medusa in the land of the Hyperboreans to kill her as a wedding gift to his mother's treacherous suitor. Medusa had been transformed by Athena into a being so supernaturally hideous that anyone who looked her in the face, with her snake-hair, huge protruding teeth and tongue, and wings, would be turned to stone.

Perseus approached Medusa by watching her reflection in his shield, and cut off her snake-writhing head. Up from the blood leapt Chrysaos and Pegasus, the winged horse, and Perseus tucked the head into his satchel. As he flew in his winged sandals back over the Libyan desert, drops of blood fell out of the satchel from the head and boiled up into snakes.

In the catasterism, Algol is the eye of the Gorgon, and hence is also known as the Demon Star. It apparently gets its name from the Arabic, al Ghul, meaning "the demon's head," and according to Robert Burnham was listed on star maps of the seventeenth century as "The Spectre's Head." The Chinese called it "Tseih She, or the Piled Up Corpses," and Burnham says: "Ancient and medieval astrologers considered Algol the most unfortunate star in the heavens."

To us of scientific mind, this is a playful if somewhat morbid story to accompany our observations of the ancient star-groups. The ominous nature of Algol might suggest (at least to Burnham) that the ancient myth-makers and astronomers had noted the brightening and dimming, and regarded it as unnatural and foreboding, the celestial bodies being otherwise divine, and perfect. If this is true then the story is telling us more about the human imagination than about the star itself. And certainly the ancients never claimed to know any more about the stars than that they were bright and eternal, which human beings obviously were – are – not.

The story depicts a deep inner complexity which is triggered or – better, perhaps – generated in the meeting point of the strange star and the mind. The star stirs a sense of foreboding, a sense that the cosmos in its veils conceals more than the human mind can consciously grasp. Behind a star which noticeably dims every three days or so, there is a god, Poseidon maybe, engendering some unfathomable act upon a woman, Medusa, maybe, raping her in Athena's own temple. In her anger Athena, of all gods and goddesses less formidable than only Poseidon, Zeus and Hades, makes Medusa unsightly, eclipsing her previous existence and turning her very appearance into a malevolence.

That malevolence stirs a foreboding and terror latent in the almost-frost of fall evenings. The story reflects the entire emotional and intuitive response of the mind to the star itself, its own uncertain light in a field of certain lights. The mind makes reality of starlight. Certainly this is a frontier more troubling than a sheet of paper showing magnitude, mass and distance.

* * *

It's troubling because the story itself has in common parlance "survived" for thousands of years, and survival suggests life: The story is still alive. And yet, of course, it is merely a shifting bundle of words formed and reformed in different languages for different purposes and applied to the imagination of a group of stars which were, unknown to the ancient Greeks, merely luminous balls of gas generating light by nuclear fusion.

Myths, in other words, seem like little more than good fun to us. On the other hand, there is the troubling sense that the "survival" of the Perseus myth suggests life of some kind, and with that suggestion comes some nervousness about Algol. In a sense there are two ways of coming to grips with the nervousness: One is to take the objective, scientific view that Perseus is an array of mega-distant stars associated almost stochastically; they happen to be there, humans happen to have noticed a pattern in them, and Algol happens to change magnitude. The trouble with this is that it posits an objectivity that Neils Bohr's complementarity principle explains to be impossible. Just noticing changes the outcome of the experience.

The second way of coming to grips with any nervousness about Algol is to ask what story you're telling yourself that's making you nervous. In a way this is simply asking yourself what effect you're having on the experience. Your answer may be the myth, or the story, itself. Or it may be a slightly different version of the story in which the observable scientific facts of a shade traversing a star bind with the personae, settings and events of the story as you're telling it.

Some force or power seems to overshadow just the bare facts and darken even the most dry and dusty scientific material. The ancients saw simply starlight in the direction of Algol, but felt dread from it; they related that sense of dread in the story of Perseus and Medusa. Every science invents its own lexicon, and no science escapes using metaphors, which might be defined as the art of relating apparently unrelated things. Modern astronomy relates a word like "envelope" to "a gaseous region surrounding one or more stars," or a phrase like "dirty snowball" to a theory of the composition of comets. In the modern mind, Algol is related to other stars with similar spectra, called B stars. In the ancient mind, Algol is related to a demon, and therefore feared. The force is in the demon, not the spectrum.

* * *

In Plato's dialogue the *Phaedrus*, Socrates and his young friend Phaedrus stroll down along the stream Ilissus, looking for a pleasant spot to read a speech by a poet they both know. They notice a nice, shady plane tree in the distance, and Phaedrus points out that legend says Boreas, the North Wind, ravished Orithyia at about that spot. Socrates, the inventor of logical analysis, matter-of-factly replies, "No, it was about a quarter of a mile lower down."

Phaedrus asks Socrates if he believes the story is true. Socrates makes an interesting reply, which I'll give here in Benjamin Jowett's translation. Socrates says:

> The wise are doubtful, and I should not be singular if, like them, I too doubted [the story]. I might have a rational

> explanation that Orithyia was playing with Pharmacia, when a northern gust carried her over the neighbouring rocks; and this being the manner of her death, she was said to have been carried away by Boreas. There is a discrepancy, however, about the locality; according to another version of the story she was taken from Areopagus, and not from this place. Now I quite acknowledge that these allegories are very nice, but he is not to be envied who has to invent them; much labour and ingenuity will be required of him; and when he has once begun, he must go on and rehabilitate Hippocentaurs and chimeras dire. Gorgons and winged steeds flow in apace, and numberless other inconceivable and portentous natures. And if he is skeptical about them, and would fain reduce them one after another to the rules of probability, this sort of crude philosophy will take up a great deal of time. Now I have no leisure for such enquiries; shall I tell you why? I must first know myself, as the Delphian inscription says; to be curious about that which is not my concern, while I am still in ignorance of my own self, would be ridiculous. And therefore I bid farewell to all this; the common opinion is enough for me. For, as I was saying, I want to know not about this, but about myself: am I a monster more complicated and swollen with passion than the serpent Typhon, or a creature of a gentler and simpler sort, to whom Nature has given a diviner and lowlier destiny? *(Phaedrus, 229c-230a)*

In this translation, Socrates' answer to Phaedrus' question is that "the common opinion is enough for me" because the trouble with trying to explain rationally, or scientifically, the events and characters and settings of myth is that the amount of time, energy and cleverness needed would distract him from his real task, which is (following Apollo's dictum at Delphi) to know himself. This phrase in Socrates' lexicon is equivalent to: to discover the truth. Objectively disproving every myth would not help him discover the truth at all.

Socrates seems neither to believe nor to disbelieve the myth, which was in his time the accepted belief. In our time, the scientific fact is the accepted belief. Socrates, for example, would likewise be satisfied with the story that Helios the Sun harnessed his horses and drove his chariot across the sky every day. We, on the other hand, are satisfied with the idea that once every twenty-four hours or so the Earth rotates on its axis, exposing our side of the world to the Sun, which is a luminous ball of gas near enough to blind us, and for all intents and purposes stationary in the sky.

But the fact of either one of these explanations does little for us in the way of truth. If "the truth" is simply that while rotating we revolve around the Sun, how does that help us? The answer is, it doesn't, by itself. More is to be made of it. A sentence which recurs in grant applications and popular apologies for scientific projects is: "It helps us learn more about ourselves." This phrase is applied, for example, to the study of planetary geology, which seems utterly unrelated to Earth-problems, but whose data are used (so we're led to believe) to learn more about Earth geology; the more we know about Earth's geology, the better we can, for example, predict earthquakes and volcanoes.

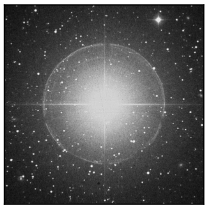
Now this all seems far off the point. Some very clever people have spent a great deal of time and energy figuring out practical rationalizations for exploring outer space, when really all that's happening is they are trying to satisfy a compelling curiosity about the universe. They are, obeying a completely human compulsion, trying to find out the truth about the cosmos. This brings us back to Socrates' offhandedness about scientific explanations. Without some human context, they are very dry.

The human context appears when an intuition or an emotion or even a compulsion suddenly completes the picture, like a bright star emerging from behind a cloud to complete a constellation. The truth of a star or a girl's death is in neither the objective facts nor the fiction built up around them. It is at a different nexus, where the observer with his or her perceptive and intellectual faculties meets the objective situation, where they all touch and are magnified or filtered into explanations for what is happening. To know, it is necessary to know not only the facts, but yourself, since you are the one who is, in the end, acting, observing the experiment, telling the story, whatever story it is.

This expression of the unity of observer, object and equipment is now grossly oversimplified. And here is what I mean: In the *Phaedrus* Socrates goes on to point out that good rhetoric depends not only on a capacity to arrange words effectively, but on, moreover, the knowledge of the truth of what you are saying. With Socrates the truth is always revealed to be elusive, and in his discussion with young Phaedrus Socrates strongly suggests that the truth emerges not from those who seem wise and scientific, but from those who seem mad. There are different kinds of madness, and among them the madnesses inspired by gods, such as love, poetry and philosophy, are madnesses in which the world is seen in its reality. The truth, in this view, is that some kind of divinity inheres in the universe, and no statement can approach the truth unless it accounts for that underlying mystery.

The absolute self, that “you” which is possible to know, is far more complicated than any of us would like to imagine. In fact, it is probably nothing like what we believe, and beyond our capacity to understand by ourselves. The whole notion of “god” or “gods” is no idle or hasty metaphor for the sentiment, “Gee, that eclipse is strange.” It is not a figure of speech which happened, ten or twenty thousand years ago, to stick. It is a way of saying that things happen in the universe which surpass human comprehension and, at some level, investigation. It is a way of saying that the nexus of our understanding achieves something both in and larger than ourselves; to try to see it would be like trying to view the whole ocean from a dinghy in the trough of two waves a thousand miles from shore. To have this view you would need to rise completely above your tiny dinghy, and the sight would be impossible to describe: tremendous triangular glistening blue waves, whitecapped, spray-ridden, extending infinitely in all directions, so extensive your eyes shut automatically, and you realize that the glare of the Sun on the sea-surface is so bright you have in any case been blinded, in a colossal prescience of dazzling azure.

That would be a kind of madness to avoid. There would be no words to represent such an experience. You would be thrown back on yourself, tiny there in the midst of enormous breaking rollers. You would know intuitively that the whole of it was unimaginable to you, and therefore unreal in any objective sense. It occurred all in your mind, somewhere, deep in the unsurveyed deserts and boreal forests of your psyche, near its most violent earthquakes and volcanoes, under Algol.



* * *

There is an aspect of reality which, when glimpsed from just the right angle, is maddening. Often, as in a nightmare, it is nothing tangible or solidly visible, but simply a presence or a force lurking in the brush. Sometimes it's more direct, like the sudden awareness of exactly how enormous and how empty interstellar space is. Algol's distance of seventy-two light-years seems in a relative sense inconsiderable, the entire galaxy being one hundred thousand light-years across, and the next sizable galaxy being 2.5 million light-years away. But one light-year alone is an incomprehensible span; in fact it isn't even useful to think of a light-year as a distance, which is why we speak of it as a year. The distance to Algol, mostly blank except for patches of dust and gas, is truly fearful because it is so unreal.

We come to grips with the dread of such an emptiness by reducing it to terms more our size. “Seventy-two” is a manageable number; its spatial counterpart, 72 years x 186,282 miles per second, is not. We create facts and categories which stand for these colossal notions, and they seem objective to us because we have reduced the horror of them. This is not a way of knowing ourselves, really, but of evading ourselves. Socrates would accept this terminology as easily as he accepted the mythological terminology, and with no more nor less belief in it. The facts, in other words, are not the truth.

They are an element of the truth. The second element is that part of the mind which joins the interstellar void and creates a monster out of it. The mind plays on the night sky, on constellations, on single stars, Algol. It is not the spectral class, visual magnitude, distance in light-years, or mass relative to the Sun that works on the mind; those are merely facts which we use to comfort ourselves by assuring that stars are not gods but gases. It’s the searing of its light on the inner mind which is memorable. The sky full of stars is beautiful, and one star, at least, is frightening. These experiences are all of a piece, at one point.

I myself have frozen in terror under Algol. I’ve spent many clear nights in an alfalfa field up the road from my house. It’s a big field, for Maine. Thick maple, popple, pin cherry and hophornbeam woods line its two ends, a quarter of a mile apart. An old cemetery lies beyond the trees on the north end, and paved camp roads skirt the sides, half a mile or so apart, with pine woods edging those two roads. The farmer hays the field two or three times every summer.

At dusk the field is tremendously beautiful. The wind stills. Swallows and swifts chip and dart, bobolinks sway precariously on weeds, and on clear evenings the sky goes deep slowly, violet all along the eastern line of trees, reddening and then silvering puffy clouds to gray-blue in the west. By late September the field has that cool nut smell of fallen leaves, the air is sharp, the alfalfa's cut, and the grass is brown and stiff.

One September night, as on many nights, I drove my pickup before dark into the middle of the field and set up my small black reflecting telescope. I pulled out the legs of a card table and a half-shredded lawn chair, and piled on the table a cardboard sheaf of star maps which I can hardly read, a small flashlight, binoculars, a planisphere to see what time a star or galaxy will rise, and a hardbound book with smaller and less reliable maps. I sat at the card table for awhile, letting the sunlight fade and the darkness deepen. By September the mosquitoes have been frostbitten themselves, and that night the air was dry and the sky transpired to that panorama of crystal fires which burns in the psyche of every human being. The whole pattern of stars is probably genetically encoded and inscribed in us as the archetype of heaven.

The more darkness there is, the more sounds there are. The rush of cars along the Bangor Road was magnified, even though the trees obscured their lights. Dogs barked occasionally in the nearby dairy farm, and their voices carried for what must have been miles. Owls hooted, and loons ululated desperately from the lake a half mile down the camp road. As always there was movement sometimes in the alders a football field away, or in the brush beside the barn. The darker it gets, the louder every sound seems.

With the binoculars I spotted M31, a brush-stroke of light southeast of Cassiopeia. This is the nearby galaxy, 2.5 million light-years away. It provides my mind, I fantasize night in and night out, a comfort in the deep black. This is a fortunate mark on the map. Sweeping easterly I ran straight into Perseus, and Algol, the Gorgon's eye, is the lead star.

I've stared at Algol through the binoculars and through the telescope, and it always starts as just another point of light. Turning the lenses on Mirfak or Capella nearby, or Altair, it isn't much different, not quite as bright as those others. But the longer you look at a star or a planet through a lens, the clearer it becomes. Your eye begins to notice things you didn't even guess at in the first ten minutes. Jupiter gets streaky, or a star takes on a distinct color and quality of brightness. For the time you're watching it, you can tell the star apart from any other, and if your visual memory is good, for long afterward. I aimed the yard-long tube of my telescope at Perseus and looked for a few minutes at the star clusters jewel-like against the blackness over Perseus's body.

Then I shifted to Algol. Normally it's white but somehow dimmer than other stars which seem simply white-cold. This might be an effect of the eclipsing, or of the moonlike phases of the fainter star. The eclipses and phases are of course impossible for me to see in my small telescope. The light alone, the quality of it, comes to me. It seems to change from night to night. What causes the change, on any given night, also is not clear. Sometimes the weather is bad, it's windy or damp or some thin mist miles high veils the sky. Dampness causes condensation on the binocular lenses or on the telescope, and starlight becomes watery or fuzzy. Or if it's not the equipment, sometimes it's me, too impatient or my eyes too weary to look correctly.

The human mind plays tricks in the dark, with no fullness of illumination on the dead grass or the maple leaves. The loon calls occurred often enough not to startle me on that night, but as always there were stranger woods noises which did not repeat. It's the stillness, somehow, and the emptiness of darkness, which pin the mind down and require it to make something no light has made or muffled. Only the sound and yourself are left to meet there, in the sweet starlight.

Or in the case of Algol, not sweet starlight but the imagination of disaster: not a god, but a demon, the opposite of providence – dis-aster, not-star. The dim notion that the ancient astronomers and philosophers knew, in their own terms, as much of the truth as we know swam up and hung itself on that point of light. I thought: *This is the eye of the Gorgon's head, which Perseus cut off and holds in front of him, blood gushing out of its throat over the pines, snakes hatching from the smoky drops in the swamp beyond Ward Hill*.

It was all mere fantasy, though. There are no Gorgons. The real undoing of this star is in the mind. There is an infection here, I thought, the sense that I should not even look, let alone with this intensity, at this star. The Medusa turned whoever saw her face to stone – Perseus saw the long row of writhing-silent stone figures on the path to Medusa's house, and later showed Atlas her head, fixed on his shield, and turned even the Titan to a mountain of stone.

This was more fantasy, evading the nexus of the whole night, which was the stillness and the starlight, and the frost of fear that seemed to invade even the notion of an "eclipsing binary." This star is strange, and it was not clear whether the strangeness was all mine or partly the star's, or perhaps even wholly the star's. The medieval astrologers were right maybe: We are at the mercy of the stars, like shipwrecked sailors in a dinghy at the mercy of the wind and sea. We're shaped and fated by the stars from birth. And if we give ourselves to the wrong stars, our catastrophe is our own souls.

But these wanderings too were the imagination of fate, not providence or the power of the human mind. Now a dimness overshadowed Algol in the telescope lens, and forgetting about the weather I felt the hair rise on the back of my neck. It was a cold September night, Algol's light beside the other points and streaming clusters between Perseus and Cassiopeia. The air was very still. Then something rustled near the trees some yards to the east of me, and suddenly a strange loud low-pitched hollow whistling I had never heard before and have not heard since boiled up out of the grass or the trees and persisted for many seconds, piercing me. I later wrote: "I nearly panicked, forgetting I too am dangerous." I was so terrified my lower lip quivered and my arms touching the telescope were paralyzed.

I watched myself freeze with fear as though part of me were miles away. It was strange to see myself so scared, and one calm part of my mind observed another frantic part of my mind which would have screamed if it could have gained control of my vocal cords and run for the road if it could have gotten my legs. I observed, and said: *Strange, I've never been this scared in my life.* My lips trembled uncontrollably.

I stopped looking at Algol and jerked my head up automatically from the telescope. The whistle stopped, and I listened with all my might for more sounds, any rustling or sound of padded footsteps or slithering. My panicked mind eddied for a moment on the fear of the cemetery up the road, whose ghouls conceivably could emerge like smoke from holes and amble through the grass, their hollow sockets and rattling dishlike skeletons foraging for eyes to petrify and shut. There was only the darkness across the field. My heart pounded, and slowly my lips took shape again. The frantic part of my mind leapt out crazily toward the star and now I could move. I tipped my head back and saw the visor of my baseball cap go up, saw the white points against the darkness, found Perseus's body, Mirfak at the top, then riding east focused on Algol again at the end of his arm.

The telescope loomed dark and angular beside me. I could move and now began to think, and I did not bend over the lens protruding from the side of the four and a half inch tube. I stared at the slippery dim light. The observing mind said: *I have never been this scared in my life. What animal makes a whistle that loud and horrible? What's dead in the raspberry thicket near the barn?* There was no struggle or war for control of my body, or my mind, there were only the immobile calm of my observation, and the disaster of my fear. I created a monster.

* * *

I loosened clamps and lifted the tube of the telescope off its iron mount. I set it in the back of the pickup, unscrewed the lens and tossed that into the plastic box on the card table. I then folded the legs of the heavy wooden tripod and loaded that into the back of the pickup too. Then shining the flashlight nervously on every imagined sound and motion in the dead grass I closed up my maps and books, packed everything else into the box, put it all and the card table into the back of the truck, banged the tailgate shut, turned on the engine and the headlights, and drove home.

My monster was a glimpse, only, no more than a sound, as sudden to go as to come. The life of it, and the truth of it, is surely that it was generated in my mind. Feeding on the starlight bathed in whatever atmospheric turbulence there was that night, and on the myth, and on the weird bird or animal call from inside the trees, and on my willingness to fear, my mind generated some whole event that was as real and intense – if finally innocuous – as anything I've ever experienced.

The mind has power. Not to take such a remark lightly, it's a power beyond the capacity to invent technologies, tame environments, record ideas, though these too are formidable powers, in their practical essences. The mind's power is more than over matter, let's say. It's a power, beyond mere will and ratiocination, to shape all reality, including that reality which occurs inside the psyche. The mind is not composed of thought and will alone, but of emotion and, deeper, intuitions and recollections which act as fusions of reality. The powerful and debilitating emotion of fear is like a spiral of energy, screwing into and out of the inmost human activity, where everything moves and solidifies perpetually, without rest.

The emotions are like vortices emerging from and pouring into the eternal mind itself. That eternal mind is constantly in the process of making relationships, connections, solutions between itself and the cosmos which it knows itself to be integrally a part of, like drops in water, or letters in a word, inherent and irreducibly there and active. The emotions, screwing in and out, in and out, carry whole makings, generations – whole seas and paragraphs – back and forth between the making mind and the aware mind. It is well to realize that the emotions are the starlight of reality, carrying signals of powers normally so distant from our awareness that we have no real sense of their magnitude or size. Some of these powers are gigadistant, like quasars generating stupendous energies of invention, and some are near enough to be overshadowed, and sometimes eclipsed, by a powerful emotion like fear, something like Algol sharing luminosity between one brighter star and its one dimmer companion – and a third, perhaps a fourth star in the system too, complicating everything.

The emotions, unleashed on the mind's generations as the cosmos passes in and out, have the capacity to brighten or darken reality. The variable star of consciousness can be at the mercy of wild emotions, like the unruly horse described by Socrates in the *Phaedrus*, and in this case there is sometimes much to be concerned about. Not always, or even usually. Not in the cases of fantasies about Algol-demons and nocturnal whistlings. But in the cases of actual living generations, those made things which the mind has invested most powerfully: in the case of a myth which is so powerful it survives eons of human history, or the case of a simple but powerful naming, like naming a group of northern stars "the Bear" – a name so profoundly connected to the workings of the universe that cultures as disparate as the ancient Greek and the ancient Iroquois called the group of stars the same name, the Great Bear. That is an example of a living inscription of the generating mind.

The emotions gyring and communicating in to out, and out to in, sometimes refine these living creations. The refinements are the things of myth, powerful stories, or in the case of a writer, the carefully reflected and shaped recollections of inner changes (evolutions of the inner spirit: changes sometimes willed, sometimes simply chosen, sometimes acting out of the mind's control) which come to us in writings. These deep emotive inventions are clarifications of inner shapes, and when the emotions shed their wildness, guided by the well-disciplined horse of the *Phaedrus*, they derive from sources deeper than the gyres at the edge of the conscious and unconscious minds. These clarifications are intuitions, brilliances passed forward uneclipsed, undarkened from the inmost mind's activities.

But there is much to be concerned about when the emotions are variable, eclipsing and unruly. Beyond the simple fears generated by fantasies that bubble up from the aerated top parts of the making mind, such as a fear induced by Algol's light on an autumn night, there are powerful creations gone awry, which must be dangerous. Myth is full of Gorgons that turn the body to stone, wildly violent Typhons, devouring Hydras, winged Geryons, vicious three-headed Cerberuses at the gates of hell, satanic demons, ugliness and horror which seems to transcend, or underpass, night fears and dreads. The evil part of the universe exists, too, when the mind coils emotions around its star and quasar generations, and the force of invention degenerates to insectlike brutality, eating, mangling and rotting the newborn babies of the soul.

This is the significance of the night-world: It is darkness itself, if the will to fear goes undisciplined. But it is the star-studded potential of all the universe, if otherwise. Or taken from a different perspective, if you view knowledge as an endless desert of individual facts, then that view will probably desiccate your creations; if knowledge bubbles from the springs of whole, indivisible interactions, then that view will probably water your experiences. Change your view of your knowledge, and you change the outcome of your observations, and ultimately of your creations.

It is not a simple choice, however. You can't say simply, one night, "I will not fear," or "I'll pay attention to the starlight, not the darkness," or "the Earth is not a ball of dusty data," because the fear and the darkness and the attitude are still there, like an interweaving of the inner and the physical world. Not to be denied. But at some particular point which may not be locatable, given the velocity of our charge through life, there is a clear experience of the illusion of material reality, of the physical world not being the way we think or hope it is, of the real fear, not of the animal or its claws but of the stupendous energy swirling in every atom. The energy of the universe concerns us most because it's our energy, our force.

I began here by taking a tremendous risk. I meant to construct a fiction more horrible than my psyche seems capable of enduring, a fiction which could blow my soul to pieces like a fusion reaction. I have not constructed those fictions, or allowed those generations onto these pages. The feel of them waiting there behind the spiral conduit of fear that perpetrated my immobility in the field, under Algol, overpowers my will to experiment with creation. I could, in other words, create with words a scene so horrible to me that only my own will could pull me through it. I don't, now, want to risk the reality of that imagination, because it might be a quasar-generation, and who knows what living monster, if I were to leak it through my fear and weakness and animosity, I could make of the sweetness of my bright, happy little son.

Instead, perhaps, let me track that fiction down in its stone-figure halls and kill it by seeing its reflection here. The truth of my own psyche emerges constantly onto this page, in other words. These are only marks, half star-struck and half night-veiled, that reflect some sense of that reality I meant to experiment with. But the risk of their coming to life in the mind, and therefore in the cosmos, is too great. Probably the imagination of monsters any time is a risk too dangerous for anyone's soul to run, though the truth, particularly the inner truth, cannot be ignored and must always be risked, especially when Medusa has somehow been by Athena transformed and solidified. Instead, let's say, Stars are gods, and begin our observations from that point of view. From there, Algol’s light is quite surrounded by the protectors of the universe.

## DIAMOND STARS

A few years ago some astronomers announced some curious things they had learned about the white dwarf star BPM 37093, about fifty light-years away in the constellation Centaurus. The core of BPM 37093, they said, appears to be a diamond weighing about 10 billion trillion trillion carats.

How in the world does a star become a diamond?

In astroscience-speak, stars are likened to living beings. The formation of new stars is called "star birth." It occurs in "stellar nurseries" where gas and dust twine together, attract more gas and dust, and eventually accrete to a mass that starts to contract and create heat. If it gets large enough, it ignites in nuclear fusion.

Over about 30 million years, a star the sun's size matures from youth into a sort of middle-aged stability in which the star burns by fusing hydrogen in its core. For stars like the Sun, this period of adulthood lasts about 10 billion years. Eventually, as in all life forms, the star starts to run out of energy – hydrogen fuel, to be exact. As this happens, a complex interplay of contraction and gravitation pushes the nuclear processes into the outer layers of the star, and it swells and in early old age becomes a red giant.

Elderly stars with masses about half again or more than the Sun can die spectacular deaths. The core starts to contract, and the contraction becomes so enormous that the core implodes, triggering an inconceivably huge explosion called a supernova. The remains, in one scenario, collapse into a ball roughly ten miles wide with a mass greater than the Sun. This neutron star spins wildly fast, emits radiation but no light, and eventually cools and buckles. In stars three times or more larger than the Sun, the remains of the supernova explosion become so dense they can't stop collapsing. Their gravity becomes so concentrated that space and time are twisted out of all recognizable shape and even photons of light can't escape. The star seems to disappear into itself and becomes a black hole.

Average-mass stars like the Sun age more gracefully. They cool slowly over the billion or so years of the red giant stage. After a while their outer layers become unstable and begin to disperse. What's left shrinks and turns into a white dwarf, which is a star about the mass of the Sun shrunken to about the size of the Earth. The remains of its life in the mainstream star sequence are densely packed, and stay hot but give off little in the way of energy. Over a few billion years the heat generated in their density radiates away, and eventually the white dwarf cools and fades into the night sky as a lonely chunk called a black dwarf.

In those last few billions of years before it cools and winks out, a white dwarf's inner material can fuse into carbon and crystallize into diamond, which is apparently what happened to BPM 37093.

The vast majority of stars, like people, burn out and fade away into the heavens. It's the natural process of life. Some stars are so large and powerful in their time that even after they've vanished from the visible world into a black hole of otherworld space-time, the invisible remains can serve as the central axis of a whole galaxy of living stars. And then there are stars that in their old age retire from their bright heydays as the centers of solar systems or – who knows? – points in constellations seen from faraway planets. They turn inward to their white-dwarf cores as if, now that the outer layers are shed, hardening and polishing what's left into 10 billion trillion trillion carat diamonds.

There is a lot to be learned from these stars. There are not very many of them among the hundreds of billions in our galaxy, so you have to know what signs to look for, like the astronomers who identified BPM 37093. But what crystals they hold, if only you can understand them.

# NIGHT FLIGHT

Suspended over the fir trees out my front door summer evenings is the star Altair. It's the brightest in a flat diamond of stars poised at an oblique angle over the trees, making up part of the constellation Aquila.

It's also one of the three bright stars in what's called in recent times the Summer Triangle: Altair, Deneb and Vega. To see the triangle around 9 or 10 o'clock in August, look toward the top of the sky – the brightest thing you see is Vega. Sweep left, and the star not quite as bright as Vega is Deneb. Altair toward the southern horizon is the apex of the equilateral triangle.

For quite a long time, the stars in this part of the sky have been associated with birds, or so the scholars say.

The name Altair comes from a phrase in the seventh- or eighth-century Arabic name for the constellation, Al Nasr al Ta'ir, the Flying Eagle, and means roughly "the rising one." The Babylonians and Sumerians three thousand years or more ago probably called it the Eagle Star, as did the Greeks later on. Aquila is Latin for eagle, the constellation's name in Roman times. The easily visible star just above Altair is Tarazed, and dimmer just below it is Alshain, both taken from an ancient Persian name for the whole asterism, Shahin tara zed, meaning in one translation "the star-striking falcon." Anyway it's an image of sweeping power rendered there in the stars.

Aquila still flies there summer nights above the treetops in central Maine. And higher to the east is Cygnus, the Swan, an easily spotted cross of six stars. Deneb is the top of the cross and the tail (al dhanab, in Arabic) of the swan. The central star is Sadr, the breast, and the lower star of the cross piece is Gienah, from the Arabic al janah, "the wing" of the swan or also the Hen for Arab astronomers. The Greeks also called the constellation

Cycnos, the Swan, and simply Ornis, the Bird. Whatever you name it, that kind of grace is unmistakable there, in those stars.

Near the zenith on summer nights is Vega in the constellation Lyra, the Lyre, with one of the oldest continuously used star names from Arab sources. Indigenous Arab people called Vega Al Nasr al Waqi, variously translated as "the eagle the falling one," or "the swooping eagle (or vulture)," or also "stone eagle of the desert." The word Vega after a millennium of use seems to derive from waqi. The Romans called the constellation the Lyre, and the bird and music imagery were synthesized by the time Galileo turned telescopes skyward around 1610. The blue beauty of Vega, like a large bird in flight or like music, or both, is a force of grace and harmony there in the stars.

For being stationary, these powerful birds reflect kaleidoscoping wheels of motion, and they are not alone. Shot from the bow of the archer Sagittarius – who is low on the horizon (behind my firs) during July and August – and flying on a trajectory that has missed the eagle and will in some mythic future just miss the swan, is the arrow, Sagitta. It skirted Scutum, the Shield, where one of the most graceful of all star clusters dots the sky (also obscured by trees at my house), known in the 1700s as M11 and later the Wild Duck Cluster. In a small telescope it looks, if your mind rises to its level, like a distant flock of ducks scattering, or so W.H. Smyth thought in the 1800s. The feel of it, at least, mirrors the other powerful flight taking place in the summer stars.

The ancient astronomers couldn't see the Wild Duck Cluster, having no telescopes. And the truth is, the only constellation of all those named here whose dots connect to an image anything like its name is Cygnus. Even then, what we see there literally at a glance is a cross, not a swan. But like everything else in life, the more you watch the triangle of Aquila, Deneb and Vega, the more there transforms in the eye. A lot more.

Even though they're fixed, these stars are in a special kind of flight relative to the season and the pointed firs. It's not just that they’re enormous nuclear furnaces – so are the stars of Orion and the Big Dipper. These are revealing some cosmic motion peculiar to them that inspires a peculiar kind of awe. The awe you feel is your detection of that motion. An underlying motion, like powerful birds on the wing at night.

## CASSIOPEIA

On October nights Cassiopeia rolls into the darkness over the cedars and pointed firs behind my house in central Maine. Blue-white stars and nebulae surround her like jewels.

She was the queen of Ethiopia, wife of Cepheus. She once bragged that she and her daughter Andromeda were more beautiful than the daughters of Nereus, and her vanity enraged Poseidon, who sent a monster to ravage her territories. An oracle told Cepheus the way to appease Poseidon was to sacrifice Andromeda, so he had her chained naked to a rock and left to be eaten. Perseus, who had recently killed the Gorgon Medusa, flew by and rescued Andromeda. Under the circumstances Cassiopeia and Cepheus agreed to let Perseus marry her, but after some intrigue, Cassiopeia double-crossed Perseus and tried to have him killed. Perseus turned the attackers into stone with the Gorgon's head, and Poseidon threw Cassiopeia into the sky to punish her – she whirls around up there on her throne for eternity, a reminder of the misery that comes to those who defy the gods.

Her beauty glimmers there worlds away in Maine, even when she's upside down, and it makes you wonder what the daughters of Nereus could have looked like. In her seat she resembles a sort of cubist W. These five stars all shine, astronomers inform us, at about magnitude 2.5, except for Epsilon (ε) Cassiopeia, the star that shoots out at an angle and throws the W out of balance, at her feet. That star, called Segin, is fainter than the other four, but even when scudding clouds commit erasures in the heavens and you can't quite distinguish, your eye supplies it, knowing where it's supposed to be.

Cassiopeia's knee bends at the star above Segin, Delta (δ) Cassiopeia, which is called Ruchbah, from the Arabic Al Ruchbah, the knee. In some texts the name is given as Ksora. As you work your way carefully back along the W, she's seated on her throne at the central star, Gamma (γ), known sometimes as Cih, which Robert Burnham explains went from magnitude 2.25 to about 1.6 in the late 1930s, then decreased to 3 by 1940, and returned to about 2.3, as though it was sending signals. So far no one has a clue why it might have varied like that.

Above γ Cassiopeia, at the apex of the symmetric part of the W, is the Alpha (α) star, known as Schedir or Schedar from the Arabic Al Sadr, the breast. And at her shoulder is Beta (β) Cassiopeia, called Caph from an Arabic name for the constellation, Kaff al Hadib, which one source gives as meaning "hand stained with henna." Arab astronomers also called Cassiopeia Al Dhat al Kursiyy, meaning "the lady in the chair," similar to another Greek name, meaning "she of the chair."

The longer you stare at Cassiopeia, the more beautiful she seems, despite her enormous, lonely distance. The stars of her chair range from about fifty to about five hundred ninety light-years away. You can imagine, not spatial distances that flagrant, but what it would be like to ride starlight from there to Earth, or beams of light converging from galactic nebulae and clusters of burning stars. They shine there all night, year after year, backward and forward across the millennia. It all glitters with some inescapable meaning.

* * *

Let me tell you about my cat. He's an unusual specimen, not so much because of his physical beauty – though being a descendant of Maine coon cats he has thick orange and white fur, a full, symmetrical face, green eyes, strong-looking paws, horselike shoulders, and a fat striped tail like a raccoon's – but unusual because of his intelligence. He knows his household chores exceptionally well and eliminates the mice and red squirrels who chew our log walls to pieces, sometimes lining up their dead bodies tidily on the porch for us to inspect. He sleeps on the chair by the bay window during off-hours. He's very neat and clean, even for a cat, and his petitions for breakfast and departure by the front door are straightforward and reasonable. He lives in our world comfortably and purposefully.

When he was little he watched television, and liked basketball games. His head moved back and forth with the game, and sometimes he tapped the screen with his paw to snag whatever was moving there. What did he see? Human shapes in glints of light? I imagine the TV perplexed him because there was motion, but only glass to touch, darkly as it were. Despite his intelligence, he couldn't catch anything as concrete as a squirrel and finally desisted from trying. A prudent cat too, maybe, although saying so is tricky because it's not clear how, or if, his sense of reality intersects with ours.

He keenly understands that the crackle of a metal pull-tab means food. He recognizes the unique rumble of our cars and runs out to greet us when we drive up, and also hides when strange vehicles pull in. We and he find similar meanings in certain sounds, at least.

On the other hand, he pretty surely has no concept of pre-packaging, or of transport. He doesn't know that every day I drive away to the elementary school to pick up my son. He's never seen a school, and even if he saw one he'd have no conception of what happens there – no sense, of any kind, of children laughing about a picture in a book, or of arithmetic problems, or of a young man with cockeyed glasses bringing his guitar each week and singing Christmas songs. As far as the cat is concerned, the school and its activities are in another dimension completely, like lights moving on a glass screen. You could say he and we experience realities so radically different that for all intents and purposes, we inhabit separate universes.

I wonder what he thinks books are. They surround him, piled on tables, crammed into shelves, stacked on the floor. Inside, where a cat has never been, letters of the alphabet represent words and groups of words – not only of Roman alphabets, but of Greek, Cyrillic, Arabic and Chinese characters too – in practically unlimited combinations that have dazzling effects on the mind. To Sparky words themselves are only vaguely meaningful sounds, like the crackling of a pull-tab.

Copies of *Walden*, Robert Graves's *Greek Myths*, *Burnham's Celestial Handbook* (three volumes), Annie Dillard's *Teaching a Stone to Talk*, a translation of poems by Rumi, and the *Shorter Oxford English Dictionary* are stacked on the desk. These books not only contain their own texts, but they allude to each other and to millions of other books at both conscious and intuitive levels, coalescing meaning from individual and collective memories of many kinds – meaning that develops from intimate relations between the words and the mind that can recognize them.

There is no evidence Sparky has any notion of this reality, even as a dream or a fantasy in his individual, isolated cat mind. Even though he sleeps with his head resting among the books, the experience of language in them is as remote and invisible to him as the remnants of Tycho's Star ten thousand light-years away are to us. More so. Sparky can't learn to read, and I doubt if he'd presume to try.

I think he sees stars, but I can't imagine what they are to him. For a cat, outer space is in a very real sense another world, unknown and unguessed. He's aware of the Sun, certainly, but doesn't know it's a thermonuclear fireball 93 million miles windward. He's aware of moonlight but has no way of knowing human bootprints mark the solid surface of that light. He doesn't know that planets travel elliptical paths around the Sun, or that moons of rock and ice orbit planets. He has no idea that comets whirl around the solar system like a cloud of gnats, or that ancient human beings believed planets were gods. He has no sense that his own body is made of stardust, or that his life originated billions of years ago from organic molecules that dropped from space on comet debris like spermatozoa.

To him, that universe is gone. He doesn't live in that dimension, even though he's in it.

* * *

Light burns down through space carrying information about the size, brightness and heat of stars, and maybe their distance. Ruchbah, δ Cassiopeia, shines at magnitude 2.68, or thereabouts. It's a spectrum A5 V star, eleven or twelve times as luminous as the Sun, and floats in space about eighty-eight light-years from Earth. Caph, β Cassiopeia, shines at about magnitude 2.5, with a luminosity twenty-two times the Sun's; it's a spectrum F2 IV or III star, forty-five or forty-nine light-years away. Segin: magnitude 3.38; luminosity one thousand times the Sun's; spectrum B3 IV or III; distance five hundred twenty to five hundred ninety light-years.

These facts are sorted from starlight. It is very precise information, even though some of it, especially the distances, is approximated. It's as if the stars were speaking and astronomers found the right way to listen – with mathematics, computers, telescopes and other light-gathering and sorting equipment – to understand what they say.

Now, the ancient mythologers were listening to the stars in Cassiopeia, too. There has been great interest in the yearly motions of the constellations for millennia at least, and for practically that long, people have been calculating and recalculating the distance of the Sun and Moon from the Earth. By the second century A.D., Ptolemy of Alexandria had refined the maps of the planetary motions so thoroughly that his calculations – although showing a few vexing discrepancies, especially in the orbits of Mars and Mercury – were the standard for astrologers and astronomers in European and Arab learned circles for about fourteen hundred years.

Ptolemy was looking for a kind of information different from what astronomers seek today. He and, much later, Kepler and Galileo were all interested in precise mathematics of planetary motion, but not as an end in itself: They wanted to know the details so they could hear what the stars are saying – what they mean.

In the ancient world myriads of ideas circulated about the possible meanings of the stars, expressed in everything from mythological tales to astrological tables to careful metaphysical speculation. Plato warned the speculators: Make sure you preserve the phenomena. It was a fourth-century B.C. way of saying: Make sure you don't depart from the observable facts, in your interpretation of planet and star light.

It turned out, as Ptolemy and then Kepler, Galileo, Newton and Einstein looked closer and closer, that the phenomena were minutely detailed and that – as Edwin Hubble verified by 1925 – the universe itself was much physically bigger than anyone had ever imagined. Ten billion to 20 billion light-years from here to there, a long way, though where "here" and "there" are is a matter of some uncertainty. It also turned out, by the end of the twentieth century, that ninety percent of the matter that calculations show must exist, cannot be seen – it's missing.

In the twenty-first century the sheer quantity of data available to astronomers is mind-boggling, especially in comparison to what was available just a hundred years ago. And yet, despite the gargantuan catalogs of star facts and established astrophysical theory, planetary information returned by Apollo, Viking, Voyager, Mars Pathfinder, the Galileo probe, the Hubble Space Telescope, and so on, all astronomers are well aware of the other fact that, relatively speaking, hardly anything is known about outer space.

There are more stars in the sky than there are grains of sand in the beaches of the world, and there are planets riding rough and smooth around most of those stars. And on those planets, what?

What are we supposed to do with the fact that ρ Cassiopeia is eleven thousand light-years away from us, shines at magnitude 4.6, shows a spectrum in a category called F8 Ia, and is one hundred twenty five thousand times as luminous as the Sun? This is curious but superficial information, really. Not much different from a cat seeing lights on a television screen and putting a paw to the glass.

* * *

Johannes Kepler set out in the sixteenth century to reach behind the glass, the way Newton and Einstein later wanted to see what makes the universe tick. In Kepler's time the sky was thought to be an image of heaven: The stars, planets, Sun and Moon moved so regularly and precisely, they were understood as the moving picture of divine order. If God could be glimpsed, it was in the sky. The planets orbited infallibly, even if the exact mathematics of their motions seemed a few fractions beyond human understanding. Everything had remained the same in the sky for as long as anyone could remember, which was a long, long time in human terms. In the same century Kepler was born, after all, Copernicus made a model of a Sun-centered universe which tried to improve on Ptolemy's fourteen hundred-year-old, viable but flawed depiction of sky phenomena. The sky and its inhabitants are that stable.

But in November 1572, a year after Kepler was born, something extremely unsettling happened. A new star appeared in Cassiopeia which had not been there before. For a couple of weeks it was so bright it was visible during the day. This was utterly shocking. The traditional European philosophies were rocked by the "nova" sometimes called Tycho's Star (after the Danish astronomer Tycho Brahe) near the star we now call Kappa (κ) Cassiopeia. Speaking from a religious view, it could not be happening. The firmament was God's figure of eternity, which unlike the world, existed in total impermeable harmony.

The anomaly had to be explained, somehow, and Kepler's lifelong pursuit, which took form in the decades after the explosion that created the new star, was to demonstrate the mathematical detail of God's perfection in the planetary motions. The *Harmonies of the World* was his titanic effort to reveal God's unfoldment of the material world according to mathematical principles. While things are not quite right here on Earth, the perfection of the heavens could be revealed through mathematics.

Numbers, after all, were from at least the time of Pythagoras expressions of divine power. You can see this depicted in the great cosmological structures of Western and Middle Eastern cultures. Multiples of 3, 7 and 9 abound in these structures, corresponding to observations of the sky. Before the invention of the telescope, there were seven celestial bodies: Sun, Mercury, Venus, Moon, Mars, Jupiter, Saturn, implying seven realms of reality. Eudoxus and later Aristotle gave the clearest early shape to this in a description of the universe as a series of concentric spheres. How many spheres there were depended on how the philosopher explained the complexities of the planets' motions within the spheres. Then beyond the planets, obviously, are the fixed stars, another visible realm. And something moved them all – a force intimate with or identical to God. Nine worlds. "Your body's about 6 feet or so," the great Persian poet and mystic Rumi says in one translation, "but your soul rises through nine levels of sky."

About the same time as Rumi, St. Thomas Aquinas showed there were nine orders of angels, and a bit later Dante showed how these orders inhabited and qualified the nine spheres of heaven, which by that time were capped by the Empyrean, the transcendent realm of God. Ibn Arabi, a predecessor of Rumi, described spectacular journeys through states and stations of consciousness unseen in the physical world.

None of these people was small-minded or merely superstitious. They turned enormous intellectual energy on the problem of who and where we are. They used the available data – the phenomena – to shape their understanding of their observations and experience.

Kepler worked squarely in their tradition, but lived at a moment of profound philosophical and epistemological change. The new, short-lived star (now referred to as B Cassiopeia) told a story different from anything Aristotle, Ibn Arabi, Aquinas, Rumi or Dante had ever imagined. From here at the beginning of the twenty-first century, the nova in Cassiopeia can be read like a symbol, as a harbinger of things to come. Galileo was only eight years old when the new star appeared, but within a few decades he corroborated that the heavens are not as stable as they appear when he saw for the first time moons orbiting Jupiter and spots disfiguring the Sun. His effort was not to debunk God, as centuries later those who followed him would attempt to do. His effort was to note what was there and try to propose a physical explanation. In those days, it was still taken more or less for granted by Galileo and Kepler, and in the next century by Newton, that God is manifest in the physical world. The possibility that physical explanations could be formulated conflicted with few people's acceptance of God's existence, really.

Kepler undertook one of the most intense intellectual labors in human history trying to make a mathematical map of the orbits of the planets. His work laid the foundations of modern planetary science, but it did not yield the result he expected.

His mathematical approach to the planets revealed not God's perfection, but imperfection – the planetary orbits were not perfect circles, but ellipses. The new star, the moons of Jupiter, the sunspots, the ellipses all suggested that God and the world were not what scriptures said they were. Because the authority of the Bible was so powerful and because scientific methods showed a world different from what the Bible described, a split developed in popular consciousness between the religious depiction of reality and the scientific depiction of reality.

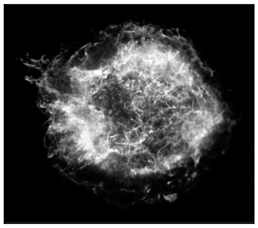
Kepler's and Galileo's revelations upset religion and philosophy, and eventually society in general. The more data were collected about where we actually are, the more it looked like we are nowhere.

Across the eighteenth, nineteenth and twentieth centuries, distances in space grew bigger and bigger – too big to comprehend. And as space expanded, so did time. Victorian scientists proposed the universe was several million years old, which sat badly enough with the clerics who believed on biblical evidence that it was four thousand and seven years old. In the twentieth century, millions of years expanded to billions, and eventually it became clear that the Earth itself is about 4.5 billion years old, but younger than the universe at large by 9 billion years or so.

About a hundred years after the explosion of B Cassiopeia, another star, Cassiopeia A, exploded, halfway to Cepheus. No one knew it. Kepler was dead by then and Newton was culling the *Harmonies of the World* for his predecessor's planetary insights, totally unaware of Cassiopeia A. No one, in fact, had any idea that Cassiopeia A even existed until 1944 when a strong source of radio waves was noticed in that region of the sky. By compiling radio data over about fourteen years, astronomers eventually concluded the activity they were detecting came from the remnants of an exploded star. Their painstaking analysis led them to believe a star had gone supernova there in about 1680.

No one ever saw the star Cassiopeia A. We know it existed, though, because a form of light invisible to the eye carries information to us which astronomers can analyze to create a factual picture of what never touched human senses. In one way of looking, some things can be seen behind the glass.

* * *



*Cassiopeia A*

But the meaning of it, at least to me, is dark. What do I make of the fact that the remnant of a supernova in Cassiopeia is emitting radio waves?

In some scientific lexicons, the waves are referred to as "signals." But this can't be the right word for it. Are the shreds and filaments of Cassiopeia A's remains signaling us, as if with some kind of intention?

Do the darting lights on the television screen signal the cat? Certainly, a human being watching a basketball game or a drama on television makes something meaningful of it, even though the cat doesn't. The light signals the human mind that can understand it. Apparently it does not signal the cat, though – he gave up.

I keep looking at the stars. I know meaning is being assembled from starlight, but somehow, the factual meanings – distance, luminosity, spectral class – do not say much to me. It's like light flickering on a screen: Despite its high rational order, the light's factual reality speaks to me little more than the images of basketball players spoke to the cat. It's tempting to just give up and take a nap.

But I keep thinking of Kepler gazing night after night at the sky, and measuring, calculating for years to find the mathematical mirror that would identify – not God, but the presence and mechanism of God's perfection. That would be true meaning. A fact, Thoreau observes in his essay "A Natural History of Massachusetts," may one day flower in a truth.

Meaning does not inhere in the objective presence of matter. It does not reside in planet rocks or star fires. Meaning inheres in relations. The way, for example, certain stars relate to each other visually in the sky, together with the eye that recognizes, or makes, the pattern. The eye catches the details, notices repeated motions, and focuses them in minute detail. The detail turns out to be not only visual or auditory, but also unseen, or as we say in the scientific world, abstract – as in mathematics, and in the processes of inductive logic.

There are other orders of unseen detail – emotions, and when you test the waters of certain kinds of religious experience, you discover evidence of inner "states and stations," as the Sufis say, that are as refined as any mathematics, but of a totally different order of existence.

What is hard to grasp, here in the age of science, is that the Sufi world of emotions, psychic states, or stations of consciousness, has any reality at all. Since there is no factual evidence for the objective existence of psychic states – for the reality of a dream, for instance – then there is no evidence the state or dream has any existence outside the chemical-driven fantasies of an isolated, individual mind. No objective facts seem to signal their existence. Starlight, on the other hand, comes to the eye in spectra and magnitude.

Or does it?

About ninety-six percent of the matter in the universe has never been detected. When you look at the sky, are you like a young, virile cat watching a TV screen? Or have you given up looking, and go with a hum about your business with no sense of what's happening in the astrophysics department of the university fifty miles away?

Up there, on autumn nights behind my house in the Maine woods, stars cover the black sky, and only a tiny of fraction of all that throws light is visible. I understand some rudimentary astronomy, I have a general picture, thanks to Kepler, of how the planets move, and I can say sentences that contain facts about the length and breadth of the universe. But I can only dream of what's at work inside and beyond those spheres.

The constellations look to me like a sphere of reality. In outer space, worlds circulate within worlds – moons within planetary orbits, planets within star orbits, stars within swirling galactic flows. Inside those lights, what is happening?

Cassiopeia speaks. This much I know. When she rolls slowly in the northeast over the cedars and pointed firs a few feet from my bed, a sense of a relation ripples through me and flowers. She troubles my sleep, whatever sleep it is. In my unconscious state, her beauty arises like smoldering fires. I have the sense that this is her data and they are virtually unreadable. To believe it is, may be arrogance of disastrous potential. She spins there for something like eternity.

What elementary schools are conducting their cheerful business at this very moment out behind the stars of Cassiopeia?

# GLIESE 581

You can't see infinity. Somehow you know it exists, though.

This weird fact was pointed out by the Italian philosopher Giordano Bruno in 1584, and sixteen years later he was burned at the stake for saying so. Or, it was one thing he said that got him in trouble. He also said the universe itself is infinite and has an infinite number of suns with infinite habitable planets circling around them.

These ideas contradicted the established wisdom of Inquisition authorities who some years later threw Galileo in prison just for saying the Earth circles around the sun.

It turns out four hundred years later that we still can't see infinity. But powerful telescopes have apparently seen to the edge of everything and collected information that implies Bruno might, for all intents and purposes, have been right. More evidence of planets circling stars cropped up in 2007 when astronomers announced that a possibly habitable planet appears to be revolving around a star called Gliese 581.

Gliese 581, a red dwarf, is so small and far away that it was invisible to Galileo (and to Bruno too, though he never looked through a telescope), like almost all of the stars where astronomers believe planets are orbiting. (Seven hundred sixty-three as of April 2012, according to the *Extrasolar Planets Encyclopaedia*.) The planets themselves are so small they are mostly impossible even for telescopes to spot.

To figure out whether a star has any planets, astronomers watch how the star's light behaves. Although they seem stationary, all stars are in motion, which can be detected through astrometry, the measurement of the positions and motions of celestial bodies. So can their speed, or radial velocity. A planet affects a star's motion or speed, and so when either of these varies in certain ways, then a planet may be present. Also, a planet passing between a star and us may dim the star's light, and this can be measured by photometry, which is the measurement of light's properties. Astronomers measure the variations, turn the measurements into mathematical equations, and reason logically from what the equations imply about the light. Planet Gliese 581c was detected by the radial velocity method.

In a few cases telescopes have taken pictures of actual planets, a method called direct imaging. But so far most extrasolar planets are too small and too close to their stars' glare to be actually seen. They do exist, though, if the astronomers' reasoning is right.

Some astronomers think it's possible most stars have planets. How many might be habitable by humans is debatable because so far most of the planets detected appear to be large and gaseous like Jupiter, or so close to their stars the weather would be deadly to life as we know it. Planet Gliese 581c seems to be an Earth-like size, and at a distance from its sun that may make it warm enough to have liquid water – which, logically, means that beings like those on Earth could inhabit it.

Now, Giordano Bruno was not a scientist. But he arrived logically at this idea: "There are innumerable suns, and an infinite number of earths revolve around those suns, just as the seven [planets] we can observe revolve around this sun which is close to us. … We discern only the largest suns, immense bodies. But we do not discern the earths because, being much smaller, they are invisible to us." Given the billions of billions of stars that apparently exist, this idea is in principle pretty much the same one some modern astronomers have.

1584. Lucky guess. Or is infinity, despite being invisible, recognizable by some combination of perception, reason and imagination common to scientists, philosophers, and even the rest of us? I hesitate to answer, not wanting to get in hot water with the authorities.

# NEBULAE

Before telescopes were invented in the early 1600s, most of what we now know exists in outer space was completely unimagined and largely unimaginable by ordinary human beings (like us). Galileo observed bizarre and shocking things – spots on the Sun, planetlings orbiting Jupiter, countless stars never seen before – which exploded ideas about the cosmos in the old philosophies.

Certain fuzzy washes of light – a handful of which (like the great galaxy in the constellation Andromeda) can be seen by the unaided eye – were revealed in telescopes to exist by the dozens, and more. For decades in the 1600s and 1700s it was generally assumed that the washes of light were all of the same ilk, although what that ilk was, was unknown. By the mid-1700s telescopes had improved, more starlight was charted, and new ideas about the structure of the cosmos were formulating out of the old. Many wild notions about the fuzzy patches eventually condensed into two basic theories: the "nebular hypothesis" and the "island universe" hypothesis.

The Latin word "nebula" means "cloud," and the nebular hypothesis was that the fuzzy patches were distant clouds of gas slowly coalescing into planets. The French mathematician Pierre-Simon LaPlace suggested that our own Sun and planets had formed this way. Even more spectacular was the idea proposed by the mighty Enlightenment philosopher Immanuel Kant that the clouds were extremely distant island universes – collections of stars beyond our own collection, the Milky Way galaxy.

It turned out both, overall, were right. There are extragalactic galaxies, and there are several kinds of nebulae. Two hundred and some years later it's a generally accepted fact of astronomy that so many galaxies exist outside our own galaxy, so far away, that their exact number is essentially unknowable. Galaxy M31 in Andromeda is an island in outer space of possibly a trillion stars about 2.5 million light-years away.

The nebulae seen in telescopes are inside our own galaxy. A nebula, as astronomers use the word, is a cloud of gas and dust floating near stars. Four basic kinds are detected in telescopes: reflection, emission, dark and planetary. A reflection nebula reflects visible light from nearby stars strongly enough for telescopes to pick up. An emission nebula glows with heat, or energy, detected by telescopes that pick up light in wavelengths the human eye can't see (which is most of the light there is).

A dark, or absorption, nebula is a cloud of gas and dust that neither reflects light nor emits heat, but instead is seen as a silhouette against a background of star or nebula light. A dark nebula familiar in Hubble Space Telescope pictures is the Horsehead Nebula.

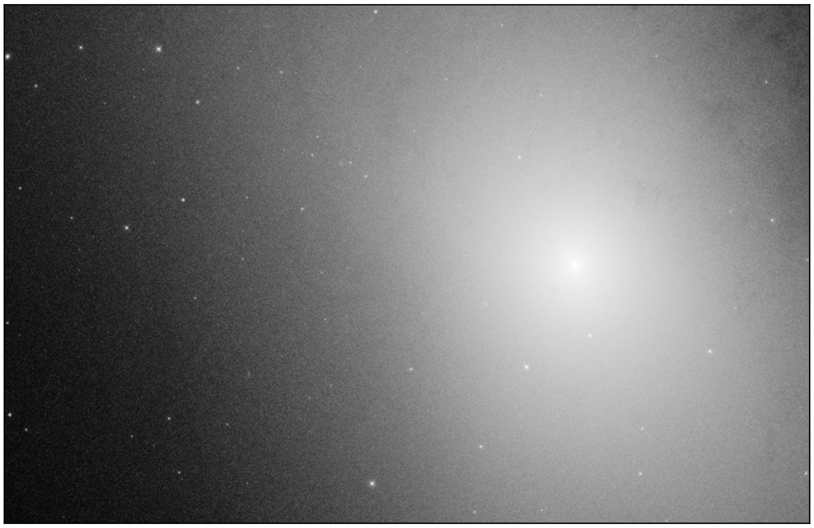
A planetary nebula is a shell of gas surrounding an old star. It does not actually involve planets – the phrase is a linguistic fragment left over from the ideas of philosophers like LaPlace and Kant.

It is theorized that stars are created when dust and gas condense over immensely long periods of time, and that planets coalesce from the disks of material left over from star formation. At the end of their lives, some stars explode into gas, dust and energy. New stars reformulate out of the material from the old exploded stars.

What a star explosion or a star birth is actually like, is unimaginable by ordinary beings like us. But that doesn't stop us from trying to figure it out. As with all serious human inquiry – scientific, philosophic, religious – it took centuries of hyper-careful observation and intellectual energy to get the reasonably accurate descriptions of the nebulae into focus. The physical picture of the cosmos is a lot clearer now than it was two hundred years ago, but in some ways the clouds of scientific unknowing are greater than ever. By the 1990s it was evident to cosmologists that upwards of 90 percent of all that apparently exists in the universe as science imagines it has not been seen or even detected. In fact there are some very bright people toiling away over minute data distilled from far-distant starlight who are pretty sure the universe we see is only one among what could be an infinity of universes.

And that's just the physical cosmos out there that science has a shot at accounting for. There are whole other activities inside the mind that are as real and awe-inspiring as washes of light on the sky darkness, and more elusive than those sky nebulae were to the first astronomers. Dreams like clouds reflecting light from some unknown elsewhere. An insight silhouetted against the surface of your mind. A memory suddenly glowing up bright in your consciousness. Powerful emotions like affection or enmity appearing like radiation in the everyday scud. What are they?

As medical instruments get better, more information in more and more minute detail is compiled describing what happens in nerve and muscle tissue during these experiences. But the experiences themselves, the starlit energies of your own consciousness and the worlds it exists in, are not accounted for in biochemical statisticry. There are telescopes in philosophy and deep inside the great religions that bring these clouds of unknowing into focus. Somehow we have collectively stopped looking through them, even though many of us, maybe most of us, have the unsettling feeling that the universe we see is only one among what could be an infinity of such nebulae.



*M31 core*

# THE PARAMETERS OF GALAXIES

*"Let's see the very thing and nothing else."*
**– Wallace Stevens, "Credences of Summer"**

It is a more serious question than most people realize, I think, to ask: How can we travel the length and breadth of our galaxy? I don't want to say there are no solutions. Science fiction has conceived warp drive, subspace communications, the tesseract, suspended animation, and starship colonies journeying for generations from one star to another, and surely the human imagination has the potential to act, somehow, on whatever it conceives. But presently our most advanced space technologists are still grappling with the problems of sending human beings to Mars, which at closest approach is only a few light minutes from Earth. Given the size of just the Milky Way galaxy alone, trekking from star to star seems like a far-fetched notion. It seems doubtful, at the moment, that human beings will ever actually, physically visit and explore other planetary systems. You can't get there from here, apparently.

The problem, of course, is that the distances between objects in the galaxy prohibit the journeys. Even the nearest stars, like Alpha Centauri, Barnard's star, or Sirius, are so far away their distances are incomprehensible, simple as they seem. The main parameters restricting travel among the stars are first, the physical distances themselves, which in a Newtonian sense are pretty much constant, at least as we now perceive interstellar space, and second our understanding of those immense distances, which is to say, the properties of galaxies themselves. The problem of deep-space travel, that is, is a problem of understanding and overcoming immense distances.

In other essays I've tried to provide a sense of this immensity, but the sense does not lend itself to a single context or remark or group of remarks. To gain even a hazy understanding of the distances between visible objects in a galaxy, and even beyond galaxies, let me come down, again, to some basic facts, by way of numbers, and then discover what the numbers imply. For example, to understand small distances like a mile or twenty-five thousand miles, we generally speak of how long it takes to travel those distances. A person walking relatively briskly can cover a mile in about fifteen minutes. It is well within the range of human beings to walk across North America, some three thousand miles, over a period of several months. It would take years to walk (and sail) around the twenty-five thousand mile circumference of the Earth, but there is time enough for any healthy human being to do it. Still, when we think of walking, twenty-five thousand miles seems like a long way.

Of course these things have been said before. But that fact does not mitigate the strangeness of time and space: Light, whose constant speed is about 186,000 miles per second, travels more than seven Earth-circumferences in one second. This alone is essentially unimaginable; it's one of those things we can talk about rationally enough, but which we cannot possibly comprehend. Yet it's possible to say meaningful things with it, such as the time it takes light to travel from the Sun to the Earth (about eight minutes), or the time it took Voyager 2's radio signals to reach Earth from Neptune (about four hours).

As far as anyone knows, the speed of light is a physical constant of the universe which has obtained since the moment of creation, whatever that means, and which will obtain until the end of the universe, whatever that means. After Neptune there is Pluto, and after Pluto there is the Oort cloud of comets, and then interstellar space. The nearest star to our solar system is Alpha Centauri, a triple star system in which the nearest of the three (Proxima Centauri) is approximately 4.24 light-years away. The idea of physical "distance" begins to become unraveled in one's mind even at this relatively nearby location. A photon of light that covers more than seven Earth-circumferences in one second, covers the distance between Proxima Centauri and Earth in a little over four years.

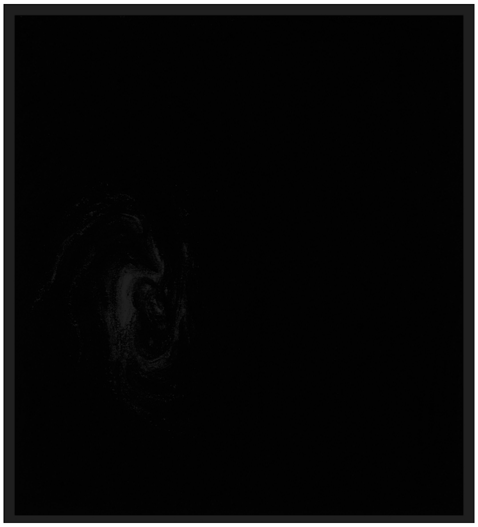
It's possible to make a scale model in your mind, to make this distance more or less recognizable. If the distance from the Earth to the Sun was six inches (six inches equals 93 million miles), then the distance to Proxima Centauri would be about twenty-six miles. Altair, the bright star in the constellation Auriga, is about 16.5 light-years distant; on the six-inch scale it would be about one hundred miles away. These stars are said to be "nearby."

Of the brightest stars in the sky, many are not nearby in comparison to Proxima Centauri and Altair. Betelgeuse, the topmost star in the familiar figure of Orion, is some five hundred and twenty light-years away; on the six-inch scale, Betelgeuse would be over three thousand miles distant. Rigel, at Orion's foot, is some nine hundred light-years from Earth, more than five thousand miles away on the six-inch scale. Where six inches, just to be clear, is equivalent to about 93 million miles.

The whole Milky Way galaxy, containing the Sun and its neighbors, and perhaps as many as 400 billion other stars of various sizes and temperatures, is thought to be about one hundred thousand light-years in diameter. The six-inch scale will not help, at this point, because even on this scale the galaxy itself is well over half a million miles in diameter. Half a million miles is not a meaningful distance; it is about twice the distance of the Moon from the Earth. You can neither walk nor even drive that far in any meaningful sense.

And yet there are galaxies beyond the one hundred thousand light-year disk of the Milky Way which are said to be "nearby" us. The Large and Small Magellanic Clouds are small irregular galaxies which appear to be orbiting the Milky Way at distances of one hundred sixty nine thousand and two hundred and five thousand light-years, respectively. M31 (the galaxy which Edwin Hubble observed to confirm his hypothesis that some nebulae actually lie outside the Milky Way galaxy and are in fact galaxies themselves) appears to be about 2.5 million light-years away. In fact there are more than fifty galaxies of varying sizes and shapes within about 10 million light-years of the Milky Way. All together these galaxies are called the Local Group.

Astronomers estimate there are perhaps 100 billion galaxies in the observable universe, maybe 170 billion, maybe more. The Local Group is near another group called the Virgo Cluster (because it is in the constellation Virgo), which spans a diameter of about 10 million light-years. The Virgo Cluster of galaxies appears to be moving, along with the Local Group, the Coma Cluster, and other clusters of galaxies, toward another cluster of clusters – or supercluster in Hercules, which is something like 400 million to 600 million light-years across. In another direction, another supercluster called Coma-A1367 seems to be traveling in the same direction as the Hercules super-cluster.



Something which appears to have a mass equivalent to tens of thousands of Milky Way galaxies over beyond the Hercules supercluster appears to be pulling everything toward it. No one knows what it is, though some presently call it "The Great Attractor" and speculate that it is composed primarily of dark matter. No one knows exactly what dark matter might be. There is some evidence to show that galaxies themselves are arranged in gigantic shells or spirals, which might be roughly concentric out to the edge of the universe, which is at best guess nowadays 13.7 billion light-years away from the Earth.

An interesting detail of this kind of gigantism is nothing. That is, we've been speaking of visible objects – material reality – such as planets, stars and galaxies, which actually exist in actual regions of space-time. We take these material objects for granted, as constants. But astronomers are beginning to show, for example, that space-time is not uniformly dense with material objects. The solar system, for example, is pretty dense. The planets, far away as they seem, orbit relatively compactly around the Sun, and clouds of dust and gas and ionized molecules in the form of "plasmas," not to mention comets, asteroids, minor planets and clouds of dirt and grit, also orbit the Sun. There is a lot of material in our solar system, despite what seem to us like enormous voids in between.

The great interstellar voids in the galaxy, empty as they are to us, are actually broken up by clouds of gas and dust and nebulae where stars are forming. And orbiting the outskirts of the galaxy's central bulge are globular clusters of very old stars packed together as densely as one star per cubic light-year. A galaxy like M31, which apparently is very similar to the Milky Way, is an opaque blur in the sky through binoculars, revealing that, despite the immense distances between stars, galaxies are in fact very dense. Clusters of twenty or so galaxies, despite distances between them of 2 million light-years and more, could also, on the right scale, be shown to have considerable density. And so could superclusters.

Yet despite these densities, there is all this empty space between stars and galaxies and clusters. And to complicate matters, there apparently are fantastic bubbles of nothing surrounded by superclusters and chains of galaxies arranged in filaments between one supercluster and another. The superclusters, that is, are not uniformly distributed through intergalactic space. An area lying some 520 million to 780 million light-years from the Milky Way, and covering 30 x 1,024 cubic light-years of space, seems to contain no galaxies at all. Nothing.

The fact that we can describe these vacant distances does not mean we comprehend them. In a sense they prohibit comprehension. And if they prohibit comprehension, then these distances surely prohibit travel. When Carl Sagan and Frank Drake said, in a *Scientific American* article, that "Electromagnetic radiation is the fastest and also the cheapest method of establishing contact [with other worlds]. ... Interstellar space vehicles cannot be excluded a priori, but in all cases they would be a slower, more expensive and more difficult means of transportation," they put it somewhat mildly. You can get there from here by bouncing light signals into space, but you can't get there from here in a spaceship.

What we're really hoping for, when we talk about exploring the galaxy, is to cross the interstellar vacancies and stand there on some reddish planet with three suns perpetually dancing along the horizon – Alpha Centauri A, B and C. You can get to Alpha Centauri from here by looking through a telescope. Or you can imagine yourself getting there by sending, as Sagan and Drake did, electromagnetic signals. Or you can even imagine yourself having been there ("we have visited all the planets except Pluto" has been a common phrase since the 1980s) by sending robots. This is close to standing on the reddish planet, but the parameters of galactic distances take over when you think of travel even this materially: The fastest explorer robots ever launched, Pioneers 10 and 11, and Voyagers 1 and 2, will take tens of thousands of years to cover about 4.3 light-years.

The solution to traveling between stars and galaxies might have to do not only with where exactly we want to go, but also with what we mean by being there.

Our sense of "being there" is bound up tightly with the methods, attitudes and ideas of science and technology. I'm saying we can't "be there," for example, because we do not have the technology to move physical objects across light-years of space within a human lifetime, or anything even remotely approaching the confines of a human lifetime. Furthermore, with some exceptions, most scientists do not expect realistically workable developments of technology for transcending the parameters of light. Not anytime soon, at least. For these reasons, "being there" cannot mean standing on the rock-red living surface of a planet outside our own solar system.

Distances even inside the galaxy restrict us from visiting worlds that far away. Our problem, if we want to travel to Planet Alpha Centauri, is to overcome the physical prohibition of traveling 4.3 light-years through an uninhabitable vacuum. A parameter of the universe is that human beings cannot physically travel from Earth to other stars.

As Drake, Sagan and Hubble have all understood, however, human beings can travel these interstellar – and intergalactic – distances in principle. Or, to put it another way, we can imagine ourselves sending representatives to and collecting representatives from these other places. We send and collect, for example, beams of electromagnetic radiation, hoping to put ourselves there, in a sense. Closer by, we send robot spacecraft to land on Mars and Venus and to fly by moons and planets, putting ourselves there.

To be there, in one sense, is to have some knowledge of there. For the scientific imagination, "knowledge" means a body of physical data, together with logical inferences about the data. Physical data are obtained from, roughly speaking, any stably, constantly occurring or recurring objects or events in the universe. Anything that can be duplicated in the laboratory, or consistently observed from one time to another, constitutes the data of science. Trees are constantly there, and as such provide scientific data. Biological systems are constantly there. The objects and events of outer space are constantly there, and can consistently be observed from one time to another. As scientific instruments become more refined and precise, the data – the numbers and the logical inferences – can change. But the objects and events remain. They are all there.

Some objects and events that are clearly there pose special problems for science. The difference, for example, between living and nonliving things is a problem for science. It is not clear what distinguishes living cells from a group of nonliving amino acids. Human consciousness, for another example, is also a problem. It is clearly there, and yet it cannot be strictly quantified or explained except as a byproduct of chemical interactions, which seems somehow gravely inadequate to personal experience. The idea that the brain is composed of complex chemical and electrical interactions explains how matter behaves in a conscious being, but it does not account for the experience of consciousness.

Another event that poses problems for science is a dream. Dreams clearly exist, they are clearly there. But their functions and indeed the parameters of their existence are merely topics for speculation. All scientists really "know" about dreams is that they exist, that they seem to occur at particular times, and that certain chemical interactions take place in the body during dreaming. Dreams are apparently a function of consciousness.

All this is to say that scientists, despite over four hundred years of methodical data-gathering and inference, really have no scientific explanation for the there of human consciousness.

We do know, however, that we can consciously imagine ourselves to have been in deep space, not only through fantasy Captain Kirk and the Starship Enterprise, but through imagination: Edwin Hubble penetrating the realm of the nebulae, planetary scientists exploring Neptune and Miranda. By imagining ourselves as having been in places beyond the Moon, we take a step toward redefining the notion of "being" in the phrase "being there."

This kind of imagination is distinctly unscientific. No one has literally "been" to Neptune. The physical distance there prohibits it. Yet the physical distance to Neptune has not prohibited it. We have been there nonetheless. And the idea that we have been there has been an exercise of the imagination, not only in imagining the technology to construct and launch Voyager, but also in imagining ourselves as spacecraft that are at the site, at the planet. There. We have extended our idea of our own being.

If the distance to Neptune has restricted us from going there in our own bodies, it has on the other hand compelled us to imagine another way of being there. The restriction of that enormous distance (four light-hours) has caused us to make a leap of imagination that is not only satisfying to human curiosity but extraordinarily exciting to the human spirit.

At the word "spirit" we are instantly beyond the realm of observable objects and events. The "human spirit" is not a valid object for scientific inquiry. In that it might be related to consciousness, and in that consciousness might be related to the chemistry of the human brain, then the spirit might one day be a legitimate topic for scientific discussion. But there is no clear evidence at all for anything like the existence of a human spirit. For science, the human spirit does not exist. And if the human spirit does not exist, then the possibilities of the human spirit do not exist.

Yet the possibility of traveling to Neptune was awake in human beings when Voyager was launched, and later some element of consciousness seized the enormous distance from Earth to Neptune and imagined that human beings have been to Neptune. This imagination is somehow in the nature of dreaming, unreal by the parameters of science, but real – a real event, a real occurrence – by the parameters of human experience. What element of consciousness can seize on the distance between stars and imagine that huge leap?

Imagining a leap to the stars is a far more enormous task than imagining the leap to Neptune because the distances to stars are far more enormous than the distance to Neptune. They are too enormous to travel in any physical sense, as we traveled to Neptune in a physical sense. But Voyager-travel was only partly physical. It was also partly imaginative. In a real, even scientific sense, we have been to Neptune, and this means the terms of the human imagination are themselves very real. At some inner juncture of consciousness where physical reality meets the imagination, a kind of dream event occurs, and reality is transformed from material to knowledge, that is to say, "reality." Perhaps the human spirit is this juncture: a space where the two parallel lines of physical reality and the imagination meet.

If so, then the physical distances between stars and galaxies are fixed limits only in imagination. In the imagination these tremendous distances may not be restrictions, but possibilities. The possibilities are titanic, at this moment, they are beyond our comprehension, swimming in a chaos of empty nothingness between stars and galaxies perhaps farther even than that. To travel these desert spaces, we are required to transcend the problem of physical distance, and that transcendence inhabits not technology, and not science as science presently defines (or restricts) the idea of "knowledge," but it inhabits the human imagination, consciousness and spirit.

Such a notion is as bewildering to the scientific mind – or to any human mind, probably – as the distances to other galaxies. What can "transcendence" mean? Broomstick riding? Astral travel? Telepathy? These terms are riddled with allusions to the restrictions of distance. Astral travel posits an ethereal body which flies around physical localities. Telepathy posits nonsensory communication across a physical distance. In *The Dragons of Eden*, Carl Sagan unwittingly expressed the poverty of this idea: "While the suggestion is sometimes made that the preferred channel of interstellar discourse will be telepathic, this seems to me at best a playful notion. At any rate, there is not the faintest evidence in support of it; and I have yet to see even moderately convincing evidence for telepathic transmission on this planet." Sagan cannot admit telepathy into the field of inquiry because it is so difficult to observe objectively: It does not seem to be exactly there, as science requires it to be. But further than a scientific objection, telepathy imagined as a "transmission" of thought implies the coverage of a measurable distance, which is exactly the problem, rather than the solution. To think of telepathy is exactly the restriction, rather than the leap.

Physical inventions probably will not leap the distance to galaxy M31. Probably the imagination will transcend that distance. It's hard to think, at this point, that the distances between stars and between galaxies are not deliberate invitations to the expansion of the human spirit. The enormity of the universe feels like a parameter of the soul. Something huge occupies every human mind and desires to grow outward to the furthest possible limit – to the furthest possible aggregation of stars, the furthest possible shell of galaxies – to inhabit it, and to know it as completely as possible.

The tendrils of the human imagination have in this century rearranged the realm of the galaxies and projected themselves into the sky and into radiotelescopes in searches for extraterrestrial intelligence. The same tendrils have ascended to Mars, Jupiter, Saturn, Uranus and Neptune, and occupied them. Probably they will scale past Neptune, and inhabit Planet Alpha Centauri, Barnard's star, Beta Pictoris, Vega, Sirius, galaxy M31. And probably when we arrive there, the planets of M31's solar systems will not look anything like the way we imagined them to look because the whole shape and existence of there will have changed for us.

The restrictions of distance are the possibilities of being: I am speaking not of afternoon fantasies of alien worlds, but of realities of the imagination, whose only parameters are the parameters of the universe itself. There is interesting fantasy but an implicit boundary to a remark like: "[Extraterrestrial beings] almost certainly will have significantly extended their intelligence extrasomatically, by employing intelligent machines." Such a speculation fails to seize the thing itself by seizing, instead, on the knowledge within its own perimeters. It defines possibilities by re-inventing what already is, instead of imagining what might be. It seizes the physical limit of empty space, instead of imagining the leap. It restricts possibilities. What "might be" is contained in the parameters of galaxies. We are not on our way from the tiny Earth to the interstellar voids.

We are already inside the voyage. The best way to think of traveling among the stars is to understand that not only is it tremendously difficult to be there in our physical bodies. It is not enough.

## NUMBERLESS

*Shanghai, China*
*January 22*

***Numbers***

No one knows how many people there are in China. The official estimate in 2001 is 1.3 billion, which is believable because every time we look out the window of our tiny apartment to the street below, there are people. My wife Bonnie observed this after she flew in with a fresh frame of reference from the woods of Maine to join our ten-year-old son Jack and me. In Shanghai, people are always everywhere. Walking. Bicycling. Jogging. Careening around in cars.

People waving their arms. People walking backwards. Old men hanging bird cages in trees. Women watering greengardens planted between a wall and a sidewalk. College girls with umbrellas. Children with sky-blue school uniforms laughing. People on the corner talking – Chinese people are out of the cradle endlessly talking.

According to the accounts of *China Daily*, between 14 million and 20 million people live in Shanghai, no one knows for sure because every day people flood in from the countryside searching for work. In Beijing there are 14 million or 15 million people. In Guangzhou there may be 13 million. A lot of medium-size cities the size of Los Angeles or larger that few Americans have ever heard of, like Quanzhou, Chengdu, Zhengzhou, Xian and Lanzhou. When we visited Xiamen last month, it had the coziness of a small American city, like Portland, Maine, where seventy thousand or so people live – in the island-city of Xiamen live 1 million people.

Punch line: Most Chinese live in the country. Around 400 million are in the cities, which implies, by arithmetic, that around 900 million live in the country. Off the record a couple of diplomats told me there are almost certainly more than 1.3 billion people in China. If I'm not mistaken, I've seen at least 1.3 billion people from my kitchen window. They flow continuously. A humming sound which must be the sound of their voices fills Shanghai even late at night.

*Shanghai*
*January 29*

***Practical matters***

Jack and I stand at the window sometimes and just watch flows of people. They meander endlessly on foot and bike along Zhengsu Road, coming onto this narrow sidestreet from the nearby main drags, Siping Road and Handan Road, and disappear into other sidestreets, Guoshun Road, Guoda Road and Guofu Road, and dozens of others we've never seen in our own neighborhood.

Jack wonders how much a billion is. So do I, and truthfully there is no way to tell because it is a number that bends down and vanishes over the horizon of your mind.

How much is a billion? How much is a million? Say you had $1 million on the day Christ was born, and you spent $1,000 a day (no interest accruing). How long would your million dollars last? A million is a thousand thousand – 1,000,000 – so it would take a thousand days to spend your $1 million. A thousand days is about 2¾ years – 2.735 years to be exact. Your million dollars would last not quite three years.

Now, if you had a billion dollars on the day Christ was born, and you spent $1,000 a day, how long would your money last? A billion is a thousand million – 1,000,000,000 – so it would take a thousand times a thousand days to spend a billion dollars. That is, it would take 2,735 years. At a thousand dollars a day, by the year 2001 you would still have about one-fourth of your money left.

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*Shanghai*
*February 6*

***Impractical matters***

How many Chinese are born every day, and how many die is a matter of great perplexity to social engineers and great mystery to others, as Annie Dillard deconcluded in her unsettling book *For the Time Being*. And whether there are 1.3 billion or 1.5 billion Chinese is so unfathomable a problem that it may not make any real difference even if it was solved. After all, there are a billion people in India too. Maybe there are 6 billion on Earth, no one knows for sure, it's too large and uncertain a number to wrap your mind around. Billions of human beings. Billions of stories.

Where do they come from, and where do they go? This obvious question leaps instantly and harmlessly out of the realm of science and statistics, and into the discredited realm of metaphysics, a branch of philosophy dealing with unseen worlds. Gung-fu tzu, known by his Euromoniker Confucius, declined to speculate on the unseen. Chinese are practical people.

Metaphysics tends to wash over into religion. It is seen as more or less theoretical, describing what appear in intuition and (subsequently) logic to be the unseen structures of the universe. Religion is more or less experiential, describing what appears in both moral and spiritual feelings to be the meaning or reality of the universe. In the age of science, metaphysics is pure speculation, and therefore discredited; and religion is a poison – the "opiate of the masses," which is a way of saying religion is no more nor less than a sociopolitical-economic tool for controlling large numbers of people. Certainly there's a good case to be made that in both Europe and China popes and emperors used people's religious beliefs to personal and political advantage.

The whole idea of "heaven" becomes seriously clouded by misuses of religion and misunderstandings of metaphysics. As a religious or metaphysical idea, heaven is a fantastic relic of the past, like an obscene stone figure from ancient Central America. The nearest meaningful use we make of the word "heaven" appears when stargazers refer to the sky as "the heavens," a harmless cliché, like the cute, fat, disturbingly grotesque face of a copy of a Mayan figurine on your coffee table. Actual heaven is billions of light-years from the everyday routines in the living room.

Instead of heaven, we have in scientific parlance "cosmology," which is the study of the constituents of the universe. The universe is made up of the visible objects, or the unseen but mathematically verifiable energies, of the Earth and sky. Much of the cosmos science describes also lurks beyond the horizon of everyday routines. Who can understand the difference between a lepton and a muon? What do we make of the chemistry teacher who informs us that electrons are not actually circling around atomic nuclei, even though he has just explained in detail how they do that?

Where do electrons come from, and where do they go? No one knows. I once read that it's estimated about $10^{72}$ atomic and subatomic particles are in existence at any given moment in the universe. This is a number with seventy-two zeroes in it. The number "1 billion" has nine zeroes in it and is already too big to think of. The Chinese speak of a million by saying a hundred ten thousand. In my sleep zeroes flow endlessly across the sky toward the sea-blue horizon, and most go out of sight.

Cosmologists figure ninety-six percent of the material universe has not been seen.

*Troy, Maine*
*Summer*

### *Heaven*

Every time I look up it begins again. The night air is thick with starlight, the pine and fir steeples point to white sprays in the sky.

Thousands of stars needle light directly at me, and in late summer the number multiplies because it is not just a spray but a thickness of stars between Sagittarius and Scorpio, like a flow of milk, in Greek γαλα. The suns encountered there number in the tens of millions at least, so many they are unresolvable by eye. The whole galaxy has at least 100 billion stars.

In Shanghai, clouded by the glow of green and orange light, the number of visible stars even on clear nights was fewer than dozens. The more layers of illumination we cast up there, the emptier the night sky seems.

### *The Unnameable*

Even by yourself in the moist night air of the country, how many stars do you not see? It is not a nameable number. Here on our edge of the Milky Way, the view to the farther wing is obscured by the galactic center, near Sagittarius, where two hundred or so globular clusters of ten thousand or a million stars each circle the star-packed core. Beyond them, unseen, are billions and billions more stars circling in the same gravitational groove as us.

Astronomers report also that the light of many millions of stars within view is too dim to reach us. And by all calculations, untold millions or possibly billions of planets orbit the stars in this neighborhood. And there are galaxies beyond our galaxy. In the Northern Hemisphere we do not see the Magellanic Clouds, smaller clumps of 10 billion or 20 billion stars each. But in dark northern skies, the untelescoped eye can discern a faint wash of light in the constellation Andromeda which is a galaxy that may be a mirror image of our own, of 400 billion stars or maybe a trillion. This galaxy, known to stargazers professional and amateur as M31, is about 2.5 million light-years distant – meaning it takes a photon of light leaping from a star there and traveling roughly 186,000 miles per second, 2.5 million years to spark silently in the retina of your eye.

If the Milky Way has around 100 billion stars (some astronomers think it may have 750 billion), and M31 has at least 400 billion stars, that's at least 500 billion stars, plus the Magellanic Clouds. But that's just in this neighborhood, the way the White Mountains of western Maine are only the nearby rises among all the Earth's high, rugged mountains, counting those powerful peaks in Colorado, and the holy Chungnang Mountains of central China, and the Himalayas, not to mention the thousands of Kilimanjaros unknown to me who lives on the edge of the Dixmont Hills.

In a Hubble telescope photo, a galaxy singled out for study in the constellation Leo may be so huge it ripples the skin on the back of your neck, but also in the photo like background noise are tens or dozens or maybe hundreds of light swirls which themselves are galaxies farther on in space-time. Not thousands, but billions of galaxies – astronomers figure there might be 80 billion to 170 billion, each with billions of stars or more. Galaxies stretch like splashing drops to the depths and breadths of the intergalactic space that has been seen through instruments.

In this context a phrase like "intergalactic space" has meaning only for convenience. It refers to something we have only observed, not experienced. And since we see it is there, somehow, we have to name it, the way we have to name zero. It is a descriptive placeholder without reference to any experienced reality. It does not compute, really.

A small enough number – such as the infinite smallness, zero – is not within a human frame of experience, and a large enough number – such as the number of stars in the universe – is in the same way not within a human frame of experience. At least, they have no identifiable logical link to a glance at the Big Dipper riding the maple tops while you walk from the garage late at night to the back door.

If you let the starlight work the back of your eyes so it soaks through into the grayness, and then pumps by electrical impulse into the heart, the heart then pumps it into your memory and your love of trees and streams. You can feel a rustling, as if the intergalactic distance was a wind on your mind's surface. The stars are still and fixed. Are the leaves moving in the evening breeze, or is the mind moving?

It's possible to watch the movements of the mind, but it must be done from the corner of the eye. If you look straight at it, it freezes like a statue – as invisible as a ghost stared at, or the way the zodiacal light is invisible until you look away, unfocusing your eyes and seeing sideways while looking straight ahead at nothing. Intergalactic distances are so transcendently huge they cannot be known at all, but only pointed at. When you look up there at night toward the beginning and end of everything, you awaken and fall asleep simultaneously. Awe and bewilderment bestir your inner eye. In the stars heaven is only felt. Its distance is unknowable.

The *Lotus Sutra* of early Buddhism refers repeatedly to "the thousand-millionfold worlds." They are "numberless as the grains of sand in the Ganges," and countless Buddhas "exist at present in … countless hundreds, thousands, ten thousands, and millions of Buddha lands in the ten directions," and there are "living beings of countless thousands, ten thousands, millions of species." There is a period of time called a "kalpa," which is so long it cannot be specified, thousands or millions of years or more, and there are "kalpas of kalpas."

The universe may have begun 13.7 billion years ago, science tells us, and a curious child will always ask, "And what came before that?" Sufis reply cheerfully to this in a way similar to *Lotus Sutra* Buddhists by referring to periods of time experienced in deep states of consciousness as pre-eternity, eternity and post-eternity.

Before there were telescopes, it was known the heavens were numberless, and the beings in them, and the time. Now, astronomers apply numbers which correspond with some verifiable accuracy to physical dimensions, but they are no more real than the *Lotus Sutra*'s. Astronomical numbers are too big to have any logic within sight of the mind. The figures, proofs, charts and diagrams are lecture material that simply glazes the mind, and can tire and actually sicken it by making the intergalactic desert places seem more distant yet. The more we chart up there, the further away it seems. The galaxies are so far from your own experience that they're simply speculations.

For the Buddhas and the Sufis, it is not a matter of physics or metaphysics, but of experience. The reports Ibn Arabi and Ruzbihan Baqli made of their journeys read like drug hallucinations. Dante gives a similar kaleidoscopic account of the regions of hell and the abstract beauties of heaven, if tempered by medieval European orderliness. Even Plato, whose razorlike rationality is widely mistaken for his principal message, speaks of giant periods of time which repeat in twenty-six thousand year cycles – a kalpa by any other name is just as big.

Where is the center of this? Two thousand four hundred years later the theory of relativity seizes the notion of "frames of reference" and places the center everywhere and nowhere – the location of the center depends upon the observer. This is all the religious mystics ever had to say on the subject, too.

The center of the universe is wherever you are now, which can easily be seen in the radiation outward of the stars and galaxies from your central vantage point. Layer upon layer of reality circling itself, from planets circling the Sun, to the Sun circling the galactic center, to clusters of galaxies moving like schools of fish, and clusters of clusters – countless thousands, ten thousands of them in ten directions at least – all moving in the same general direction of what astrophysicists call the Great Attractor, no one knows exactly what it is or how it works.

In the Buddhist temple of Longhua in Shanghai, a statue of Avalokitesvara – or Guanyin, the bodhisattva of home, peace and protection – with four faces and a thousand gold hands, sits in the center of a room, and along the inner walls from floor to ceiling are hundreds, thousands, ten thousand it seems, of carved, painted figures leaping outward in joy or fierce protectiveness, standing in serene contemplation holding staffs and fruits, laughing, glowering, gesturing with glittering eyes. Their robes, swords and scrolls are blue, red and black, and from the center of the room the stern but generous and enraptured faces of Guanyin spread her protection like a great cloud over the thousand-millionfold lands of heavenly beings and protective demons.

Numberless as the grains of sand in the Ganges, or as the miles from here to the quasar frontier. The distances between stars are so immense it will take the Pioneer spacecraft, one of the fastest contraptions ever launched, more than fifty-five thousand years to make the trip to the nearest star, Alpha Centauri, if it lives. Spaces like this separate the stars in the Milky Way, and 2.5 million light-years farther on inside M31 are spaces equally vast and yet seen from Earth as a cloud of light. Whirling clouds of light as far as the telescope can see, like countless drops of milk.

Where do galaxies come from, and where do they go? Some astronomers say the cosmos isn’t old enough for galaxies to have evolved, as creatures evolve, yet there they are. It happened more suddenly than could logically be expected, as if God had slapped the shale-like surface of the sea and sent a spray in the air. As if the thousand hands of Guanyin had slapped a thousand seas and sent a thousand thousand sprays across the cosmos, sending thousands of thousands of drops into being, that will sometime fall back and disappear there still alive. 120 billion slaps, each spraying.

In the billions of galaxies of hundreds of billions of stars, surely there is life recognizable even to us, animals and plants, and elsewise. Even the species of the Earth, contrary to popular misunderstanding, have not all been identified or cataloged – there are insects unknown to entomologists, deep-sea corals and blind fish so far unseen by anyone, and no doubt land creatures our frame of reference has not yet allowed over the horizon. No one is sure where spiders come from since there are no aquatic species and apparently they did not evolve, like everything else, from the sea. They may have come to Earth on meteors. What else is outposted in the stars, and other bewildering elsewheres?

If as the metaphysics of some religions hold, every being is a world in itself, then let's say also every world is a being. Thousands of billions of worlds circling billions and billions of stars. Billions of beings, uncountable beings in China, India, a cozy 1.3 million in Maine. Worlds of worlds – Earth beings unknown and unrecognized by science. The undiscovered country between here and heaven used to be inhabited by gods, angels, spirits and demons, and only in the last few centuries has our frame of reference pushed them over the horizon.

The far frontier for us is the nearby planets of rock and ice, empty spots where two or three – Mars, Titan, Europa – may once have grown microbes, primitive beings. In the yawning distance are the other stars, the thousand-millionfold lands seen only as echoes in the telescopic sky with planets and beings walking them, both visible and invisible. What is it that speaks from the other side of the stars? Where is that voice coming from, and where is it going? And why can't we hear it?

Or can't we? Clouds of stars illuminate the fir hills in the night air, obscuring stars and more worlds beyond, and beyond. From over the dark pine steeples around my house, light spreads like a great cloud, and there is the frightening sense that on wavelengths dancing into but unseen by my eyes, the sonor of God filling the universe with light is swelling the distance.

# SOLAR SYSTEMS

# MAGNIFICENT DESOLATION

Before I say what happened to the Moon, let me tell you what Parmenides said about reality.

Parmenides was born in the Greek city Elea, in southern Italy, in the last decades of the 500s B.C. Socrates when very young talked with the elderly Parmenides, and speaks of him in Plato's *Theaetetus* as a "being whom I respect above all ... a 'reverend and awful' figure." Socrates expresses the fear that no one understands exactly what Parmenides was talking about.

Parmenides' words have tumbled down the ages to us in a collection of fragments, most of which sound more like Orphic sayings rather than part of a coherent rational philosophy. But one of the main threads in the longer fragments is fairly simple and, to a literal-minded reader, self-evident. Parmenides says that what is, must be, and that what is not, cannot be. What difficulty Socrates might have had with remarks like these is not immediately clear. If you are grasping them, these sentences sound exactly the same, logically, as sentences like "blue must be blue" and "colors other than blue cannot be blue."

They are of course a little more complicated. Parmenides suggests straight up that the two sentences actually refer to two ways of understanding the world. One way assumes that everything that is exists and any understanding of truth and reality comes through this assumption. The other way assumes that what is not is knowable despite its nonexistence, and that an understanding of truth and reality can come through understanding what is not. Parmenides flatly says that "no information comes back" from this latter way. "You cannot know nonexistence."

This also seems obvious enough.

But as Socrates well knew, it is not really obvious. The truth of Parmenides' statements hinges completely on what you take to be real. If you take the material world to be real, then any object of your five senses is part of what is, and you can assume that accurate information about reality comes through them. This, in general, is the view of science as it has constructed itself in the last four hundred years or so. Knowledge is derived from repeatable observations of and experiments with the materials of the universe. Anything that is not experimentally or observationally verifiable is not real and is not inquired into or even spoken of. For example, most scientists ignore reports of UFOs, because there is no repeatable, verifiable evidence that UFOs – as opposed to airplanes, meteors or swamp gases – even exist. Or more interestingly, some cognitive psychologists avoid discussions of "consciousness," as though it does not exist.

But despite the instructions of science, it is not necessary to take the material world as the final reality of the cosmos. This view is most clearly represented, perhaps, in the Hindu view that the material universe is an illusion, or a shadow of reality, called *maya*. The material existence, or actual physical nature, that we perceive is called *prakriti*. The illusion itself is made of tensions between three qualities of existence called the *gunas* – roughly speaking, the qualities of inertia, restlessness and balance. Material reality is not as we perceive it; it is made of qualities rather than material substance.

This diverges a little from Parmenides, but is nonetheless similar to what he says. For Parmenides also introduces, in his fragments, the difference between being and becoming. In other words, what is, timelessly and always is whatever it is; it has being. The material world, on the other hand, is in a constant state of flux, it always changes and becomes something else. Because it is always becoming something else, it is never anything. It never is, but always becomes. The becoming is an appearance only, like a shadow, which is an absence of light – nothing appearing over something. The appearance is an illusion; it is not.

And so to Parmenides and Hindus, the material world is not, finally, what is. Its existence is not the existence we perceive, and so to believe that what we perceive is what is, is an error. Plato later developed this by saying that a material object is an image of reality, and is not the being, or what is, of the reality itself. No information about reality comes back from what is not. The material world we perceive is not real; it is an illusion of change, flux, transience.

Now in the words of Plutarch, Parmenides was "an ancient naturalist," and we should not understand that he denied our experience of the material world. But if matter is only an image of what is, then what does Parmenides say is real? An answer is in one of his cryptic fragments: "To think and to be are one and the same." If you are at all familiar with Plato, you can see from this that Socrates took Parmenides very seriously. This one sentence encapsulates a key element of everything Socrates says about reality: The noetic world – of thought and ideas – is what is, and the rest is an illusion, like the play of puppet shadows on the wall of a firelit cave.

The implications that unfold from Parmenides' simple point that "what is is and what is not is not" constitute a logical swamp of contradictions, paradoxes and strangeness. Neither Parmenides himself, nor Plato, nor Plotinus, nor any philosopher, up to and including the philosophers of quantum physics (who have had to treat quantum implications about reality in some of the same terms) has solved the logical difficulties. They agree that the human mind plays an important role in shaping the world. They disagree about what the world, or reality, actually consists of – in the same way that most readers of this essay, at this very moment of reading, are disagreeing with or muddled by the propositions about "reality" bobbing up and down in these pages.

We quite naturally, in this situation, expect science to help us keep our heads above water. For four hundred years it has instructed us that reality is constituted by objects composed of matter or, in a more refined version, energy. The intangible things of the unconscious mind, like emotions and thoughts, and even life itself, result from complex chemical reactions and exchanges of energy. Invisible and untestable notions like "the spirit" or "God" do not, in conventional scientific terms, exist and are not normally investigated by reputable scientists. In a sense science has tacitly followed Parmenides' advice by excluding from its range of investigation what scientists believe is not.

"Nature will respond in accordance with the theory with which it is approached," wrote the physicist David Bohm in 1980. If we theorize that the physical world is real and God is not real, then the physical universe will seem real to us, whether it is or not. If we theorize further that the physical world is an aggregation of essentially inert, lifeless objects, and that the objects themselves are aggregations of smaller lifeless objects, and the small objects are further aggregations of even smaller objects, where the smallest of all the objects are merely whirling and creating by their energy, motion and association the illusion of larger objects, then it will seem that the universe is essentially an aggregation of inert, lifeless, meaningless objects. According to Bohm's principle, if we approach the world as an aggregation of lifeless objects, then the universe will respond as an aggregation of lifeless objects.

This is exactly what modern science, as it is commonly practiced and understood, has found. According to one highly refined mathematical understanding of the physical nature of the universe which accounts for the properties of matter and antimatter and the universal law of the conservation of energy, the total energy in the universe is zero. Or more tangibly, every object, with only one or two exceptions, that astronomers have studied in space has been assumed or proven to be inert and lifeless. Even the Viking biology experiments on the surface of Mars, which were very hopefully designed, ended up to be at best ambiguous, but in the judgment of most scientists, nearly conclusively negative: Most agree that there is no evidence of anything alive on Mars. We assume Mars is, like the rest of the extraterrestrial universe, lifeless. Maybe there will be evidence of life on Titan or Europa, but given the scientific assumption that the universe is composed of lifelessness, the prospects are not good. More likely, robot space probes will find nothing on Titan or Europa, either.

It begins to look like conventional science has not really followed Parmenides' advice. Parmenides said that "to think and to be are one and the same." What comes into being and goes out of being – in other words *prakriti*, nature, material reality – is not what is. Science's objects of study, the aggregations of the material universe, are the fluctuating components of the world of becoming. Science is engaged, from this point of view, in the massive analysis of an illusion.

Some eminent scientists have addressed this proposition obliquely, by suggesting that science's range might be limited. In the 1920s Arthur Eddington pointed out that science examines only one aspect – the material aspect – of all that exists, and that other aspects of existence cannot be understood or even approached with scientific methods. He gives the lucid example of the impossibility of science ever explaining what is funny in a joke. His point is that in some unknown way, reality does not inhere solely in material substance. There is another range of reality.

But scientists like Eddington have not set the main course for science as it is popularly understood, practiced and utilized. We commonly think of science as the answer to all our troubles and questions, which we in turn think of as primarily material. Your intuition that God might exist is, for example, a psychological impulse; your psychology is a product of complex, highly evolved chemical and electrical actions in your brain. That is to say, your intuition, like your whole existence, is an illusion. It is not what is, and since what is not cannot be, it is essentially nothing.

Parmenides flatly states (in Stanley Lombardo’s apt translation):

That Nothingness exists will never break through.
Withhold your mind from that way of inquiry.
But don't let fashion force you to travel
the empirical road either
using the blind eye for instrument
the ringing ear and the tongue

To Parmenides, reality is your intuition and thought, not the illusions of sight and sound and crafty verbal manipulation. Parmenides’ advice was to approach nature with the theory that what is is. *Maya* and *prakriti* are only appearances; the timeless qualities which manifest themselves as thought or mind shape the world as we perceive it. Nature responds in accordance with the theory with which it is approached. If the material world is all, then all is nothing. This cannot be. No information comes back from this way.

* * *

What the Moon actually is has interested people for millennia, at least. In pre-Christian times the celestial bodies were not just divine, but in some views the divinities themselves. The Moon, being close, bright and highly regular in its phases and position, was thought to influence the Earth in many ways, and so was thought to be a cosmic power with an identity and being, in different aspects, of its own.

The ancient Greeks were interested in what the heavens were actually made of and how they were structured, and they propounded as many theories of the Moon as any other planet. Parmenides himself indicated our modern understanding of moonlight:

nightshining
          round earth
a wanderer with borrowed light

Others thought the Moon was merely a stone. Some thought it was a stone whose pores leaked light from the heavenly world. Opinion differed over whether the Moon was flat or spherical. Aetius reported that the Pythagorean Philolaos had said the Moon was Earthlike and supported plants and animals fifteen times larger than terrestrial plants and animals.

Others explained that, like all the objects in the sky, the Moon was made of the celestial fire, a pure, ethereal fire as opposed to the material fire found on Earth. This belief was held widely well into the Renaissance, and provides one of the main metaphors in Dante's celestial cosmology. On leaving Eden at the top of Mount Purgatory to embark for heaven, Dante and Beatrice pass through a final purifying wall of fire into the sphere of the Moon.

In the fifteenth century, Leonardo da Vinci thought the changes he detected in the Moon's surface appearance were caused by clouds rising from water. With inferences like this, modern, inductive observational science begins. Galileo, looking through his telescope, changed the world's lunar theories for good. He thought the dark areas he saw were literally large bodies of water, and he called them "seas." In 1651 Giambattista Riccioli followed Galileo's lead when he mapped and named the dark areas as bodies of water, for example, Lacus Somniorum, the Lake of Dreams, and Mare Tranquillitatis, the Sea of Tranquillity (site of Apollo 11's landing). He named craters after philosophers and scientists, and the names became generally accepted, though he thought of them as merely apt conventions. For religious reasons, he believed neither water nor inhabitants existed on the Moon. Riccioli's Christian conviction was a direct descendant, coming down through Aristotle, St. Augustine, Dante and other religious thinkers, of the sense that the stars and planets are made of a divine, immaterial substance.

As the methods of objective science gained authority, the Moon's divinity dissolved. Reputable eighteenth century astronomers conjectured that the Moon was Earthlike and had an atmosphere and grew plants. An early nineteenth century German astronomer speculated that the rilles, long cracks in the Moon's surface, were roads, and announced at one point that he had discovered a lunar city. Soon afterward, the astronomers Beer and Madler explained the Moon's surface features in detailed geological terms, and the modern view of a dead, rocky Moon settled into place.

To be sure, no one was unequivocally certain about the Moon's deadness. Peculiar changes of light, for example, that could not be objectively explained, continued to occur there. A reddish light glows in some craters from time to time, unpredictably. Astronomers call these glows "lunar transient events," but have no idea what they are. They still occur, unexplained, today. Astronomy textbooks give the general feeling that the glows are illusions of some kind that are either minor physical peculiarities or more likely don't concern science at all.

We do know, now, that the Moon is a lifeless ball of rock. Shortly before Apollo 11 landed on the Sea of Tranquillity in July 1969, most scientists were reasonably certain it was airless and waterless, rocky rather than icy. Apollo 8 had flown around it ten times at Christmas of 1968 and reported so. The astronauts described pretty much exactly what the scientists expected they would.

Only the fine details were still uncertain. For example, there was concern that the Moon might be harboring alien microbes with the potential to cause mass infection on the Earth, so mission planners quarantined the astronauts after the first few Apollo landings. Some geologists were concerned that Moon rocks suddenly exposed to oxygen in the spacecraft might burst into flames. At least one reputable scientist was convinced that the Moon was covered with a very light powder, into which Neil Armstrong, Buzz Aldrin and the Eagle would disappear forever.

But in general the most conventional theories were borne out. Eagle landed on firm soil. The astronauts found only rocks and ashy-smelling dust. Gravity was low. Nothing moved that the astronauts did not kick up themselves.

The Moon's mountains and plains looked different from any Earth landscape, but this too was generally predictable. Armstrong reported that the landscape appeared amazingly sharp and clear because of the lack of atmosphere, but he found it difficult to judge sizes and distances because there was nothing familiar for comparison. In brilliant sunlight the rolling land was tan-colored, and in the shadows of rocks and hills it was ashen gray. To Aldrin, coming down the ladder shortly after Armstrong, everything seemed somewhat disorderly, but peculiarly precise. It was an emptiness of rock and dust, lifeless. And yet the shapes affected them, and Armstrong said, "It has a stark beauty all its own." A few minutes later Aldrin framed the oxymoron-like fragment: "magnificent desolation."

This is exactly what the scientists, and anyone conversant with postwar science and astronomy, expected. The Moon corresponded exactly to the theory with which it was most closely approached.

* * *

Every observation, rock and bag of dust the Apollo 11 astronauts picked up in their two and a half hours of poking around on the Moon's surface was important to the scientists. The astronauts' bodily responses, conditions and functions were of great interest.

What the astronauts thought and experienced while on the Moon was of less importance. Most of the literature on the astronauts' personal, inner responses focuses on their feeling of being surrounded by beauty and desolation. All the Apollo astronauts, with few exceptions, apparently, were greatly affected by the sight of the blue, cloud-swirling Earth rising over the Moon's horizon. For the most part, not much more is made of the astronauts' inner experiences.[3]

This is because, except in clinical psychological terms, the astronauts' thoughts are of little interest to science. But Aldrin's oxymoron might be of considerable interest to Parmenides or Socrates. Aldrin had a deep sense that the world around him was desolate, which is to say, empty; it was nothing. He was there to scrutinize, as closely as he could in only a few hours, what some inner sense was telling him is not all of what is. At the same time, he and Armstrong both experienced a sense of tremendous beauty. The surface of the Moon is desolate yet magnificent.

Between desolation and magnificence, surely magnificence is of greater interest because it clearly is: It is the quality of the experience of desolation. Magnificence – or in Socratic terms, Beauty – is not the rocks and craters themselves, it is not the Earth rising over the tan aridity of the Moon. "To think and to be are one and the same." Magnificence indicates the existence, not of the rocky Moon, but of the mind that is making sense of the Moon.

The Apollo scientists, however, were intent upon the desolation. They wanted to know about the color of the rocks, their variety, the shape of landscapes, the measurements of gravity, and whatever else the public will never know about. The Moon is an object, an aggregation of lifeless substances that have undergone geological activities and lain silent and locally inert for billions of years.

It's as though, after four hundred years of figuring and re-figuring, we have focused our attention on one aspect of reality, decided it is what is, and systematically excluded all other aspects as what is not. Even though it is plain even in the mouth of the second man to step foot on the Moon that what is generally held to be not is in fact expansively what is. And even though it is plain that what is generally held to exist, does not absolutely exist: It is an illusion created by swirling particles, whose own existence is only marginally verifiable by mathematical equations and streaks of light on photographic film. The technological achievements of science are spectacular: medicine, transportation (trips to the Moon!), housing, electric lights, refrigeration of food, information processing and transmission (in hand-held computers far more powerful than the computers aboard the Apollo spacecrafts!), stupendous weaponry, and so on. But science has also explicitly denied that other spectacular ranges of human experience are even real. There is no God. A dream is an evolutionary survival mechanism. Science cannot explain the humor in a joke, and does not seek to because humor is not objective; in a very real scientific sense, humor is not real.

It was inevitable that the Apollo astronauts would find a lifeless Moon. In theory they could not find anything else. One wonders what Parmenides or Socrates would have found, if they had been able to go there. It would have included what Aldrin described, but would have radically differed because they would have approached the Sea of Tranquillity with a completely different theory of reality. They would have seen a reality indescribable and perhaps unbelievable to us. They might have told hallucinatory stories of guiding goddesses and firelit caves.

In one sense, we think of our time as a tremendous Golden Age of human existence. The rise of scientific reasoning prompted philosophers to name the eighteenth century the Age of Enlightenment, and all through the twentieth century and into the twenty-first, science has been confidently described as the most accurate and successful method for explaining and theorizing about the universe ever devised by human beings. Given the astonishing material comforts we now have, even in parts of poor countries, there is much circumstantial evidence to support the validity of this description. Parmenides the naturalist would surely be impressed. Our material lives seem magnificent.

In another sense, we think of our time as degenerate. The most horrible wars and most extensive atrocities against human beings and the planet itself were conducted in the last two hundred years. A general degeneration of moral sensibilities is described again and again, everywhere in the Western world. People in the industrialized world are bored, angry and resentful even though they have more material comforts than any human beings in any time. Our inner lives seem desolate.

If science has indeed been investigating illusions, as Parmenides' ideas suggest, then it has been returning to us more illusions. (Proudly touting the virtues of virtual reality.) Centuries from now (if they exist in human terms), will historians describe the age of science as the Great Dark Age of humanity when the knowledge of what is – the magnificence experienced by Buzz Aldrin, the thought or mind spoken of by Parmenides, Plato, Plotinus, the Vedas, Christ – was systematically eradicated and replaced by the illusory knowledge of what is not – the desolation?

* * *

When the Apollo 14 astronaut Stuart Roosa visited Nepal in 1975, he talked to some schoolchildren about his flight to the Moon. One of the kids asked, "Who did you see there?" Roosa answered, "No one. There is nothing there."

Later he learned that one of the teachers took the child aside to clarify what Roosa had said. The teacher told the child the astronaut didn't know what he was talking about. For as all Nepalese know, the Moon is where the souls of the dead go. It could not be true that "nothing is there" because Heaven is there.

Stuart Roosa and his wife felt bad about this after it happened. They wished they had been briefed more thoroughly beforehand about the culture they were visiting. This means, presumably, that Roosa felt he could, given adequate information, have framed an answer to the child's question that created the illusion that Roosa did indeed believe he had seen, on the Moon, something. Even though he thought he saw nothing.

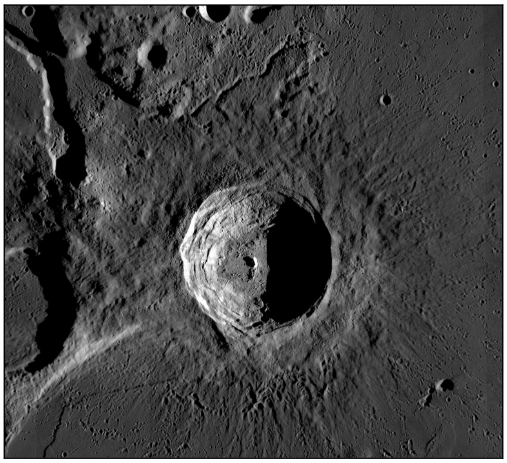
In the age of science, the belief that Heaven is in the Moon seems quaint. From another perspective, the belief that you can solve all your problems if you can just acquire enough facts, also seems sort of quaint.

Speaking and thinking are the same as what is. This does not mean, however, that we invent material reality. Both Parmenides and Neils Bohr roughly agree on these points. Parmenides declares categorically that what is, is, and that what is not, is not. This is not a matter decided by thought, but shaped by thought. Bohr says quantum physics indicates that an observer's mind plays a role, complementarily, in the results of an experiment. But this does not mean the mind reformulates the structure of molecules.

There are illusions and there are truths about reality. The natural world is (apparently) an illusion of some kind. It is an image, science explains, formed by subatomic particles. In Plato's terms, this description is nearly as far away from reality as it's possible to be, and not be in the (non-)realm of what is not. Closer to the truth will be a correct opinion of the nature of the object. This includes the object's image as a starting point (which is probably what Parmenides the naturalist meant), but also the actual object of knowledge, which is the essential being of the thing. Which Buddhists indicate is empty. Probably, in the same way that we can't know exactly what or where an electron is, we can't objectively know essential being. We are faced with our own theories and descriptions. To speak is to think.

Science is an intellectual edifice made of words. It is a vast, incomprehensibly detailed description of physical objects and events together with theories about how the objects and events relate to each other. If you tried to grasp all of science whole, in your mind, you would come up against a swamp of inconsistencies, logical contradictions, unexplainable peculiarities like lunar transient events and appearing and disappearing subatomic particles. You would find almost nothing about your actual inner experiences of beauty, conscience, courage, temperance, evil and so on; most scientific discussions of them would divert from the actual experiences and refer to them as chemical activities or as symbols without concrete reality.

It all sounds very desolate. It gives you a desolate feeling, as though you had looked directly at the surface of the Moon and seen nothing. No one is there.



*Aristarchus*

## LUNAR ECLIPSE

Unsure whether I'd ever be awake for such an event again, I placed the Earth-based 4.5-inch Newtonian reflecting telescope on the deck and aligned it to the cardinal directions, unpacked a lens filter for moonlight, hung a pair of binoculars around my neck, and aimed a lawn chair strategically south one September evening to watch the total lunar eclipse transpire in full, perfect view above my spruces and pines.

It was my third encounter with a total lunar eclipse. One I watched from an attic window on Munjoy Hill in Portland in 1982 with a blanket around my shoulders, a notebook (long lost), and an astronomy textbook. The next I watched from the campus of the State University of New York in Binghamton in 1993, and spent most of those couple of hours talking about China and the size of the cosmos with two friends.

The eclipse of September 2015 was different, not only for being in the quiet woods instead of a city, but also for being decades along in my ability to make sense out of what I was seeing. I find the whole thing more shadowy than ever.

The mechanics of a lunar eclipse – which is what I thought I was experiencing the first two go-rounds – are pretty simple, really. The Earth is orbiting around the Sun, and the Moon orbits around the Earth roughly once a month. (You can see the ghost of the word moon in the word month.) When the Earth's orbit takes it directly between the sun and moon, then the moon passes through the Earth's shadow, and is eclipsed.

It happens only when the moon is full because that's when the moon is directly opposite the sun. The reason there isn't a lunar eclipse every month is that the moon's orbit is angled about 5 degrees to the plane of the Earth's orbit of the sun. So the moon's orbit takes it through the Earth's shadow only when the orbits combine at the appropriate angles. Sometimes the moon passes through the edge, or penumbra, of the Earth's shadow producing a penumbral eclipse, or it brushes the edge of the central shadow, or umbra, producing a partial eclipse.

I was thinking hard about these mechanics in 1982 and 1993, trying to place myself in a context with them. I couldn't do it, really. The whole spherical contraption is too big and only leads to even bigger perplexities, like solar eclipses (a lunar eclipse on Earth is a solar eclipse on the moon) and the insignificance of the distance to Pluto (4 light-hours) when you compare it to the distance to the nearest star (4.2 light-years), never mind the nearest large galaxy (2.5 million light-years). (For the record, the distance from Earth's surface to the moon is about 1.3 light-seconds.)

On the deck in the clear, chilly September evening, the full moon is so bright it actually boggles your eyes in a telescope. The more so when they're wearing out anyway. So a filter on the lens cuts the glare. Craters, plains and mountain shadows, all white and gray. Soon a fuzzy convex darkness starts inching onto the moon wafer. With cosmic patience you wait, look through the binoculars, get up for a closer view in the telescope. The binoculars are better, really, because while the telescope shows the surface details, the binoculars show the whole moon suspended deep in space.

As darkness swells slowly across the moon's surface, it turns reddish, not black. The moon is still reflecting indirect light and the Earth's atmosphere filters out the blue wavelengths, letting the reddish light through. September's vanishing moon did not appear as red as the other two eclipses. At least in memory, which has a way of transforming things.

As the shadow increases, moonlight fades of course and the sky finds its off-phase dark. Stars that were invisible a little while ago emerged all over. Soon I could see the galaxy in the northeast. A few meteors streaked the sky, a couple of them bright. Eventually, inevitably, totality approached. The world was a reddish-dark orb suspended over the woods.

Down on the edge of the deck, a tiny point of light appeared. What the heck is that? It shone steadily for a minute or two. When I raised the binoculars to look at it, which would have done no good whatsoever, it winked out. All I could think of was the reflection from the back of a wolf spider's eyes. I've seen that before, and this glint on the deck was the right pinpoint size. But I don't know, and have no other rational explanation.

In the woods things moved around cracking branches like in a dream. Deer, probably. I don't know. Further back was the eight-note lyric wraith of a barred owl, often pronounced bard owl, and I suppose it is a poetry from an even deeper dark, who cooks for you?

Now and then a glint of starlight shot through the trees from outer space – when the rotating Earth aligns a clear shaft through maples and hemlocks, for a fleeting second a star at just the right angle on the skyline peeks through.

Maybe by that time I was only half-awake. The rusty moon was suspended among the stars like a being in a dream.

Myths about eclipses usually depict some kind of conflict: a battle in the sky; displeasure among the gods; a portent of death; a sign of imbalance. Since we in our scientific wisdom know the mechanics of eclipses, we dismiss the mythologies as childish, if forgivable, nonsense. Scientists have long assumed and even teach that members of “primitive” cultures mistakenly believed the moon is literally being attacked or eaten during an eclipse.

But assuming the myth makers believed the stories represent literal facts is as childishly mistaken about psychological reality as the stories are childishly mistaken about scientific reality. The Pomo Indians of the West Coast did not think the bear in their story literally attacked the moon during a lunar eclipse, any more than we think the sun literally rises in the morning.

Their story of the moon and the bear conveyed, not facts of outer physical reality, but facts of inner psychic reality. In their cosmology, the difference between outer reality and inner reality was not as sharp as our Newtonian scientific cosmologies take it to be. The boundaries between woods and dreams, Earth and sky were wider and much more shadowy to them than they are to us. You might meet a bear in the woods, or you might might him in a dream. They are identical beings in different versions of the world. In an eclipse on an abnormal evening in September, the bear that cracks branches in the woods crosses out of the dream and turns up as a shadow over the moon. The physical world and the dream world intersect in the lunar world. "The sky is just the same as the Earth, only up above, and older," goes a translated observation from a Micmac story.

For a little while the rust-colored moon hung suspended in deep space like a being in a dream. Sitting there on the deck in the trees while the moon got eaten by a shadow, I awoke to at least a penumbra of the inner life. It was disturbing and I was haunted by thoughts of loved ones who seem to me these days in tangled woods, the path lost, old fears stirring, one in particular I was helpless to lead out. Conflict, imbalance, a heavy displeasure. The atmosphere of a lunar eclipse.

It took a couple of long hours of patient watching for the Earth's shadow to cover the whole white wafer. Science promised it would equally slowly uncover and return to its eye-boggling brightness. Somehow, there on the deck in the owl-hooting woods, it seemed sort of uncertain, though. Would it really return?

Of course it would. It's mechanically inevitable. But to make sure, I left the telescope standing and waited in my chair until a slip of light re-appeared on the edge of the moon.

## FEAR OF MIMAS

Saturn’s inmost-orbiting moon, not counting five or so smaller chunks of rock and ice, is Mimas. It might be the most genuinely dead place in the solar system. Voyager 1 and Cassini photographs show so many craters, ruts, shadows and nooks over Mimas’ trailing hemisphere (the one facing away from the direction of Mimas’ orbit) that it resembles an ancient mass of coral rather than a planetary body. And a gigantic impact crater called Herschel covers more than a quarter of the surface of the leading hemisphere. Herschel’s rim-walls loft three to six miles over the other craters, in a circle eighty miles wide, and a rocky peak rises some four miles out of the center. It looks like a still photograph of a liquid drop smashing into another liquid surface. Herschel is so huge in comparison with the rest of the moon that in the Voyager photos it blots out the sense of a sphere and transforms Mimas into an object, rather than a planetary body, the way a human cadaver is something other than a human being.

Apparently Mimas barely survived the impact that created Herschel. The comet or rock that hit was six miles or so in diameter, and if that object had been slightly larger it would have blown Mimas to pieces. This would not have been the first time Mimas was destroyed. In fact, Mimas might have been annihilated and reborn as many as five times since the planets and moons originally formed 4.5 billion years ago. At some uncertain time in Saturn’s history, a tremendous bombardment occurred, smashing the new moons in the system. Rocky and icy material left over from planet-formation struggled and surged around Saturn, and some of the larger satellites were outright annihilated by impacting comets or asteroids, or by other planetesimals whose orbits were disrupted in the mayhem. The

Saturn system apparently was broken to pieces as if there had been a cosmic war.

The new debris settled into orbit around Saturn. Huge, flat rings formed from fine rock and ice material, and moons accreted again from the rest. In the midst of its own first death Mimas re-collected itself. Pieces of its original water ice and rock gravitated together in the original orbit, and formed a central mass which in turn attracted more rock and ice to those particular bends and folds in space-time. It compacted itself tightly, in the normal process of planet formation, into essentially the same roughly spherical body, in the same orbit. The same moon.

Then, after some uncertain eon, a second concentrated bombardment began. Mimas was repeatedly blasted, and Tethys, two orbits farther out, was hit by something which left a crater two hundred and fifty miles wide. Two planetesimals, Telesto and Calypso, somehow ended up in Tethys' orbit, and another one is in Dione's. Beyond Dione, Rhea and Titan, a smaller, potato-shaped moon called Hyperion angles around Saturn bent over 45 degrees on its axis, suggesting it too was struck and half-killed by something enormous and violent. The rings themselves are mainly small chunks of water ice. Saturn is surrounded by rubble.

After Mimas' most recent re-accretion into a small moon, it underwent another heavy bombardment which formed the craters on its trailing hemisphere. This suggests the impacts must have come from inside the system, because if they had come from outside in the form of, for example, comets or asteroids, then Mimas would have crashed into them headlong, and the craters would appear on the leading hemisphere. Instead, debris careening inside the Saturn system caught up to Mimas from behind. The bowl-shaped craters on the leading hemisphere are not as thick as the minefield on the trailing side, and the floor of Herschel, moreover, is relatively speaking not much pocked at all. This means the huge comet or asteroid or other debris that almost annihilated Mimas one last time came after the last serious bombardment, obliterating earlier craters.

By that time Mimas must already have been geologically dead. All over its surface the craters are sharp and deep, suggesting Mimas does not shift or grind itself: Rocks and dirt don't shake loose from hillsides because there are no tremors or erosions of any kind. Grooves up to fifty-five miles long rut parts of the trailing face, but these were probably caused by the giant impact. As far as anyone can tell, Mimas is not geologically active in any sense. It has neither volcanoes (which is not surprising, as only three places – Earth, Jupiter's Io and Neptune's Triton – are known to be active in this way) nor tectonic deformation nor even the internal heat source that most larger places have. It appears in its mass to be undifferentiated, which means it is a mixture of ice and rock that never shifted into natural places above and below each other. It seems dead.

No one knows if this is true or not, of course. Some astronomers suggest that Mimas is not dead – or has not always been dead – explaining that its compressed football shape (called a "triaxial ellipsoid") and size (about two hundred and forty miles in diameter) combined with the tidal effects of its own rotation and Saturn's tremendous gravity imply it differentiated into a small rocky core and thin mantle of ice. But the craters are so deep and sharp-rimmed that Mimas clearly has not stirred for a long time. Nothing happens there, it is simply suspended in a normal orbit one hundred and fifteen thousand miles from Saturn. It has no atmosphere. Its stillness is all, whirling round and round Saturn, like a corpse.

In scientific terms, the comparison of Mimas to a corpse implies the comparison of other planets to living bodies. The essential deadness of Mimas, for example, contrasts with the essential aliveness of Io, which is so tormented by the push and pull of Jupiter's gravity that it constantly heaves and pukes up sulfurous gas and smoke through volcanoes that appear reddish orange in color-enhanced photos by Voyager and Galileo mission spacecrafts. Io is persistently referred to as being "alive," which is an astronomical metaphor for geologically active.

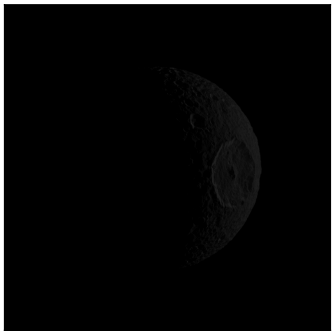
In scientific terms, it would be absurd to ask if Io is literally alive, or if Mimas is literally dead. Alive and dead are merely convenient metaphors. Spheres of rock, ice and gas cannot be said to live or die the way a human body lives or dies. From a very generalized point of view, the materials of moons and humans can be described equivalently as active or inactive, but humans, of course, are sentient, where moons are not. But if sentience makes some qualitative difference in what we mean when we speak of different pieces of the universe,[4] then when we say Mimas is dead, are we telling ourselves what Mimas is like, or what death is like?

Perhaps the metaphor wobbles a little when we unfold it to a question like this. Science uses tropes like "dead" and "alive" to characterize a situation or moon, not to express a literal fact. The trouble, however, is that the moment metaphors are introduced, the mind's rational processes are influenced or outright disrupted by other elements of the psyche. In particular, metaphors involving something as personally disturbing as death affect the emotions, and emotions in turn affect thoughts. And so imagining Mimas as a figure of death – or death as a figure of Mimas – can disrupt logical thought with the agitation we all feel, in our different ways, about our own personal deaths. If we dwell too much on the deathlike quality of Mimas, then logical thought can break up altogether, causing all the steps to disperse and the thought to come to pieces.

The image of a tiny, crater-covered rock and ice moon whirling around Saturn, which itself looms gigantic and yellow-banded in the moon's sky, can crease your chest with anxiety. If you persist in thinking of Mimas as being dead, like a pasty, wound-gouged corpse, and this fear disperses your ability to reason clearly, then you are no longer in the world of science, but in the world of actual, unmediated human experience, fearing something profoundly personal – death. Fear, however, is not science. The metaphor tilts out of control.

It's as if Mimas' deadness becomes all but real at this point. We have spoken of it so concretely and so empirically, with its rock and rocklike ice, its enormous crater mountains and its visible, almost touchable rocky chasms, that we have almost given a concrete form to death. A way to override the stark reality of it is to distance ourselves with more metaphors, creating a different sense of the same reality by invoking a myth of some sort. The myth has the peculiar value of keeping us close to the emotional impact of Mimas' deadness while at the same time allowing us the latitude to understand, scientifically tutored as we are, that the myth is not strictly true, or factual. It is comforting to think things so distant truly are this separate and different.

For example, we know that the mythical Mimas was not an actual living giant who (as Robert Graves tells us) went to war against the gods for imprisoning their brothers the Titans (Ouranos, Iapetos, Kronos (or Saturn), and so on). The god Hephaestus did not literally fling a ladle of red-hot metal into the face of Mimas, long hair and beard flying wildly in the battle, and Hercules did not literally finish him off. But it's a good story, and it retains the horror of disfigurement and finally death which originally disturbed us in our scientific metaphors about the qualitative condition of the moon Mimas.



The myth is still not science, however, and if we insist on the pre-eminence of the scientific mind, then our thoughts travel logically back to the facts of Mimas' rock and ice stillness, its pockmarked surface, its natural history of repeated accretion and annihilation. With the myth fresh in memory, a play of logical connection might call to mind the idea that sometimes mythological stories seem to chronicle natural events. For example, Hesiod's eighth century B.C. description of the violent battle between Zeus and Kronos (in Roman terms, Jupiter and Saturn) could well be his transcription of an account of the massive volcanic explosion of the Aegean island Thera in about 1450 B.C. Even more pertinent is the Velikovskian notion that the widespread myths concerning the war in heaven are descriptions or accounts of another natural cataclysm, the bombardment of Saturn and its moons. Of course the ancient storytellers, such as Graves' fifth century B.C. source Apollodorus, never knew anything about a bombardment of Saturn by asteroids, comets and interplanetary debris. Apollodorus never saw or even imagined moons orbiting Mars, Jupiter or Saturn, not to mention the wholly rational theory that moons and planets accrete from rock and ice. Most ancient people believed the planets were literally gods. They did not invent a metaphor for something they did not know or even imagine existed.

Still, the similarity of the stories of a war in heaven to the bombardment of Saturn and its moons is peculiar. To round out the play of logic with mythology, crater Herschel with its disfiguring splashlike mountains looks remarkably like the scald-wound Hephaestus gave the giant Mimas. But even John Herschel, who in 1847 named the tiny moon his father William had discovered in 1789, never saw the huge crater that was in the 1980s named after him, and so he could not have created that parallel, or figure, out of the mythological story. There can be no rational connection between the sharp-edged craters of Mimas and the wars of the gods and giants. In the same way, there should be no emotional connection between the fact of Mimas and the descriptive metaphor "dead."

Yet if we are paying attention, an internal connection unfolds whether we like it or not. It's as if deadness is enfolded in Mimas almost before we examine it, the way the story of the catastrophic war in heaven is enfolded in the catastrophic bombardment of the Saturn system almost before the story emerged. To dispel any confusion at this point, we can always return to the empirical facts. Mimas is two hundred and forty-three miles in diameter. It is only slightly denser, overall, than water. It revolves around Saturn once in just under twenty-four hours, and like most moons in the solar system, rotates with one face always toward the planet. If we could stand on Mimas, Saturn would gleam in the sky across an area five thousand times the area our full Moon covers in our sky. The rings would be an elongated ellipse before our eyes, at narrowest nine times the Moon's apparent width in the night sky. When Saturn did not obliterate it from sight, the Sun would be about the brightness of a beach bonfire. Ancient mountains surrounding craters would tooth up around us, miles high, at the disconcerting angles in vorticist line drawings. No wind or air or atmosphere or movement of any kind.

From this viewpoint it is very difficult not to think of the stillness of death. The hard, cold facts of existence can be held off only for so long until it becomes clear they are so hard and cold, particularly in this case, that even despite their distance they are affecting us somehow. And the effect is not of the facts or rocks themselves, but of something they seem to contain that our minds seem somehow to coincide with. They for all intents and purposes mimic something commonly knowable to us. The physical existence of Mimas, specifically that violent and droplike giant crater, seems to mimic or unfold in our minds into the mythological metaphor; if there was ever a fact or an actual image to correspond to Hephaestus disfiguring the giant Mimas, this crater is it. Similarly, it's inevitable that a scientist or any other human being would refer to Mimas as being "dead," because it mimics death so precisely and purely. Whether Mimas itself is or is not dead becomes almost irrelevant to the sense that it either enfolds or is an unfolding of the condition or state of death, or death itself.

There is the sense, when facts and metaphors lead us into the fear these thoughts can engender, that we are not actually talking about the same world science talks about. We are talking about some other order of existence, if the realities of the mind – including thoughts, emotions, intuitions, moral feelings, other kinds of sensibilities and apperceptions – can be termed "real." Somewhere, either in the physical object Mimas or in the play and reaction of the mind to Mimas, if the two things are different, there is a delusion of powerful verisimilitude. We have been wondering all along not about the physical parameters of the moon Mimas, but about its uniqueness and peculiarities. And having noticed that its peculiarity is that it resembles death, we are face to face with the reality of death, with our own fear of death, and with our need to somehow understand or come to terms with death. To generalize radically, it must be true that death is the one significant preoccupation common to the minds of self-conscious beings. What happens at the moment of death, and after death?

In scientific terms, these questions are empirically and mathematically unanswerable,[5] and it is commonly extrapolated, therefore, that death is a total and final oblivion, a nothing. Science, in a positivist incarnation still current in our age, assumes that where there are no empirical facts, there is nothing. It would be delusive to think there is anything else. Still, a death which is empirically nothing is frightening to most people. Nothing, here, has distinct and effective verisimilitude.

Perhaps Mimas is so disturbing because for something, it is bewilderingly like nothing. And yet Mimas must have been truly nothing during those times when it was dispersed, with no physical being at all, annihilated by bombardments of mysterious entities from in or outside Saturn's moon system. Then it did not exist at all, either in anyone's mind or in empirical fact.

But can even this be true? Because the natural history of Mimas is that it has accreted and exploded perhaps five times – it has lived five different lives. This suggests that even during the absence of a spherical body of rock and ice there was still a potential Mimas – that Mimas still existed in what we might call an enfolded form in a particular region of space-time (the vicinity of Mimas' orbital distance from the surface of Saturn), in a particular set of water ice and rock particles in or on their way to that space-time, that roughly spherical shape and, essentially, that same moon.

There is evidence, derived from an interpretation of the mathematics of quantum theory, to suggest that Mimas did exist in this enfolded form, even when it did not exist in rock-ice form. A powerful analogy from chemistry gave rise to this idea. A physicist, David Bohm, watched on television a simple experiment in which a drop of ink was dispersed in a cylinder of glycerin and then pulled back together into a single drop. This suggested that a drop which had completely dispersed but could be retrieved to its original form contained, in its dispersed form, some remaining disposition or potential to be a single drop. In other words the drop, or the disposition to the order of a drop, still existed in an enfolded form in the glycerin and the dispersed ink. Bohm eventually showed with mathematics that this potential is present in quantum systems.

The same might be said for objects on a much larger scale, say moons. Mimas has come and gone a number of times, the way a drop of ink can come and go a number of times, or a quantum system comes and goes, enfolded as a potential and then unfolded as an empirical reality. What the literal fact of this potential, or enfoldment, or unfoldment could be, no one knows, because no one knows literally what the mathematical equations of quantum mechanics refer to. Reality is not necessarily a solid, it might be a force or a shade, or the underlying disposition of the universe to unfold its potentials.

Further, no one knows what the unfoldments might consist of, other than rock and water. They might consist of metaphors themselves. If so then a myth unfolds when the mind touches a sense – or a potential, or a disposition – of some aspect of the natural history of the universe. Apollodorus' story of the war in heaven is a literal unfoldment of the same potential unfolded in the bombardment of Saturn, Mimas, Hyperion, Tethys and the other moons. John Herschel's name for the tiny, disfigured, inmost-orbiting moon of Saturn unfolds the same story and the same macro-event from billions of years before. The human mind has this power to recognize and invent metaphors which transform signs and potentials into concrete experience.

A metaphor in this sense might be more real than reality. The sense of motionless death evoked from the physical examination of pictures and data about Mimas is more humanly immanent and real than the physical object itself, which is after all 800 million miles away. It is not Mimas we fear, it's death. In the modern age, Mimas is death.

And then, unfolded in the natural history of Mimas is its disposition to recur. Mimas keeps existing, somehow, even when it is annihilated. And even when it seems imperturbably dead, orbiting Saturn absolutely inactively, there it is, existing between annihilations. Because for a certainty, Mimas will not orbit there forever but will be destroyed again in some far-distant catastrophe of asteroid-bombardment or Saturn-disruption. Like all human beings, all moons die. They spread out like a drop of ink in glycerin, dispersed to apparent nothing, but their potential, or idea, or essential relation to the unfolded physical world somehow remains enfolded in the wavelike fabric of the universe, and they accrete again. It is then a question whether sentience is required to truly live. We fear, not Mimas, but our own potential powers.

## HYPERION

By the beginning of March there's usually so much snow in our central Maine yard in the woods that we feel like we're living in a crater.

To get down our driveway, you pass between two gigantic pyramids of plow ice, like the ancient Lion Gate. The narrow dirt roadway descends and bends along a causewaylike track lined by snowbanks. Some years the banks are so high the driveway becomes a sort of twisted knothole or tunnel down across the sticks-bowered brook and beside the shipwreck leftovers of fallen and cut firs and spruces. It bottoms out under pine, maple, oak, hemlock and ash trees sifting snow out of their branches and closing out the low-angled winter sunlight – leaving the ice there two to three miles thick, or so we estimate. The tunnel then re-ascends for about thirty feet and comes out in the yard, which in early March is encircled by eight-foot mountains of plowed-up snow. Welcome to the inside of Back Troy Crater.

If you look at those steep snow walls too long you start to feel uneasy. They're covered with rocky-looking frozen debris and peaked with boulders you imagine must be the same on the slopes of K2. The walls are all moon-ice white. Buried somewhere under there is the ancient Mercedes which we only drive in summer. It's like looking, without seeing, into darkness. We're closed off from the world.

One morning I was standing in the middle of this driveway nowhere looking up at the ice walls, and started thinking I'd seen this before. Rubble-strewn snowbanks or maybe glaciers, surrounding me. It was like peering through a hole into a dark room. I wasn't sure if it was from a childhood memory, or a dream, or another lifetime in the frozen Arctic. Trying to remember was like clambering along an underground passage.

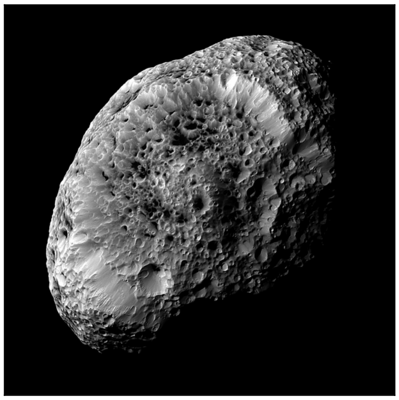
Then suddenly I was up the other side: The driveway crater was like Saturn's weird moon Hyperion.

It is a potato-shaped thing around two hundred fifty miles long and a hundred and sixty miles at its widest point (though these measurements vary from astronomer to astronomer). A spacecraft photo shows a huge crater gashing almost one whole side of it. The crater slopes are bright, steep and seem rubble-strewn. There are scores of other craters in the crater, with jagged-looking edges.

How Hyperion got that way is essentially unknown. It could be the last big chunk of a larger moon that got blown apart in a collision or in a bombardment that Saturn's environs are thought to have undergone eons ago. But Hyperion (named at the time of its discovery in 1848 after one of the Titans – upon whom little light is shed in ancient Greek texts) has other shadowy inexplicabilities, too. For one thing, instead of rotating smoothly and evenly like other moons and planets, it tumbles chaotically end over end and side over side. It orbits Saturn every twenty-one days near the much larger moon Titan, which makes three rounds for every four of Hyperion's. Every time Hyperion passes into Titan's gravity, it jostles, changes its spin axis and flails.

It turns out the jagged edges of Hyperion's craters are made of water ice, just like Back Troy Crater. Hyperion's density is so low its interior is thought to be a webwork of ice caverns. If somehow you could make your way through its constantly skewing thirteen-day spin and set foot on it, not only would you be standing at the bottom of winter looking up at ice walls, but you might also descend through openings in the craters to –300 degree caves. If you had even a little practice at looking inward you might crawl down shadowy tunnels and find frozen debris and flitting landslide motions you wouldn't think possible. If you stayed down there long enough in that titanic darkness you might eventually wonder if it was an actual place or just a state of wintermind tumbling end over end around Saturn for the rest of eternity, or at least until the next bombardment of snow and ice. The empty wreck of the cosmos there deep inside. Winter after a long time freezes you with this feeling of craterous remoteness and claustrophobia you want to crawl out of, and can't.

Anyway, along came a rainstorm the first weekend in March. The crater walls receded a little bit (thankfully for my sanity, you might say – I know I did), and the Lion Gate shrank. The increasing daylight turns the driveway from a knothole-tunnel into a mud slough. But it's a sign of a return to the humane surface of spring, here at the other end of the driveway.



## SATURN

The Cassini spacecraft sailed into orbit around Saturn in 2004, sending back strange pictures. There are weird pictures of Saturn's rings, pictures of Saturn backlit by the Sun. Strange images of some kind of jets streaming from its moon Enceladus. Pictures came back of Saturn's largest moon, Titan, showing methane lakes and undiscovered Titanic countries where, it is guardedly conjectured, life might once have spawned, died out, or could come back.

Saturn was strange all along. Its rings confused Galileo badly, mainly because of the limited capabilities of his telescopes, but also because in 1610 he did not know what he was seeing. In the later 1600s, the French astronomer Giovanni Cassini observed that the rings are not one solid plane, but divided. The Cassini spacecraft found the rings are not flat but wavy or corrugated.

The fact that we can see the rings at all is startling, given they're less than a mile thick. The three other "gas giant" planets – Jupiter, Uranus and Neptune – have rings too, but they're so wispy it took spacecraft to notice them.

In a small telescope the image of Saturn is tiny. It has a flat-white to faintly goldish sheen, lustrous like Jupiter and Mars. But unlike them it does not appear as a disk which your eye can comfortably turn into a sphere or globe. What baffled Galileo were the strange protrusions, which he at first thought were separate planets locked in place. But it was the rings. They can be disconcerting if you let them.

They're made of rock, dust and ice left over from some kind of barrage that occurred after Saturn formed about 4.5 billion years ago. Comets or asteroids (no one knows for sure what) annihilated its newly made moons and broke everything to pieces as if there had been a cosmic war. The debris settled into orbit around Saturn, and huge, flat rings formed from fine rock and ice. After some uncertain eon, it is believed, a second bombardment began. The present moons show the scars. Three small moons, Telesto, Calypso and Tethys, somehow ended up in the same orbit. Mimas has a crater almost a third of its whole diameter. Potato-shaped Hyperion angles around Saturn bent over 45 degrees on its axis, implying it was struck and half-killed by something enormous. The moons shepherd the tiny ring particles. Saturn is surrounded by rubble.

In a small telescope the rubble becomes strangely beautiful. Striking and chilling. Poe, the master of weirdness, wrote that "the tone of [beauty's] highest manifestation … is sadness," which is a strange thing to say but maybe you can grasp it when you see Saturn shining up there with its rings.

It swings slowly around the Sun once every twenty-eight years or so, brooding. In ancient times it was the remotest known planet. The Greeks called it Kronos, the father of the gods, whose name is probably linked to the word for time in the sense of huge, inexorable motion toward an end and chaos, which in the myths is sad – Kronos toppled his father Uranus, and then was overturned by his own son Zeus. The Romans called him Saturn, and in December celebrated saturnalia, a festival of reckless abandon as winter closed in. Our week ends on Saturn's day.

Maybe this is not despair, but in here somewhere is an image of life's inescapable decline. It is unlike any other phase of life, and weirdly beautiful.

# WINTER MOONS

*"The spruces rough in the distant glitter*
*Of the January sun"*
**– Wallace Stevens, "The Snow Man"**

Here in Maine, winter is long and cold. In the past it was even longer and colder, or so memory and certain old people suggest. One of Thoreau's journal entries from before 1850 notes without surprise a fairly heavy snowfall in mid-April. That was in Massachusetts, which is still part of the temperate east. Farther north and east, beyond New Hampshire, the Saco River in southern Maine is the accepted anthropological divisor of the Eastern Woodlands region from the Eastern Subarctic region. "Subarctic" refers to a length and depth of winter freeze which is something less than polar. The limits of a subarctic winter might accurately be described as the months when snow can reasonably be expected to bury everything. And in earlier times, the months when food became scarce to nonexistent. Most of Maine drowses through winter from November to April.

By late January the cold has normally been so long and so thorough that it's difficult even to stay awake. The ice grinds everything to a halt, or so close to a halt that for all intents and purposes nothing happens. The roads are frozen, and so are your bones. Snow piles up everywhere, obliterating the driveway and the baseball diamond. In fields the only signs that anything ever lived are dead spokes of grass or a few uncut corn stalks, the occasional raccoon, fox or deer tracks in the snow. You don't want to go outside. You want to stay in where the heat is, smell the wood smoke or the dry nylon odor of electric coils. The inner staleness of the kitchen, unventilated since October. A house is a core of warmth, like a burrow. It seems unutterably small after a while, but at least it's not frozen. In the cold we describe even the warm by what it's not.

Cold is the absence of heat. Ice is that pervasive presence in the universe which signifies what is not. Sometimes on really arctic nights the ice – or maybe not the ice itself but its stillness and hardness – becomes fascinating, and you can feel sucked outside to see the emptiness. Away from the artificial fires of western culture, which throw smoke and black soot all over chunky roadside snowbanks, the snow in the woods remains purely white, even during its porous melting period in March. The whiteness is a blankness, even more complete than on the ocean surface because it does not move. Billions of tiny frozen water crystals, motionless, piling up around the hemlocks and in the arms of pines, bluish in moon shadows. Everything suspended, waiting for the Sun to come up.

Especially at night. The air is emptied of moisture, and to breathe is to suck in pure cold, like blocks of ice tumbling into your lungs. In arctic cold, –10, –20 Fahrenheit and colder, a deep breath extinguishes the vascular heat in your chest, and a sharp pain creases your sternum. You breathe slowly to preserve the inner reserves of warmth.

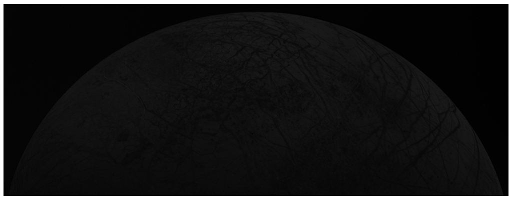
I saw the emptiness completely one moonless January midnight when I walked on the pond to look at Orion. The camp road was slick with crushed powdery snow over a slab of ice. The stars were thick, like magnified crystals in the blackness. On the pond my boots blasted oblong impact pits into the glazed snow. I thought the pond must be frozen completely through to the bottom.

Everything seemed impregnable, as if the cold itself was insulation. In the first stages of freezing there is nervousness. When the chill penetrates your skin, you have a natural inclination to move, which for most people means shivering. As the cold filters further into your bones your body becomes calmer, and drowsiness takes over. A desire to succumb sets in, like a cat settling into a chair, and a fascination for sleep dulls the desire to survive. In its final phase, I imagine, it solidifies into a need to relinquish consciousness completely and become ice. Standing on the pond, binoculars in glove, I kept shivering. The emptiness yawned all around me. Flat, dark ice reposed like a moonscape, sometimes buckling and creaking as if the Earth itself could shiver. In a rough circle around the pond's edges loomed pointed giants, spruces and pines.

It was like standing in a still crater. Rim mountains spoked up all around me. The impact basin was flat, pocked with tiny holes. The arctic cold of the Earth, I thought, is the same as the Moon's, or Triton's, or Charon's. Absence is absence. Nothing is nothing. You can die of sleep as easily here as there. For a few minutes I relaxed. Stars plainly rising over a crater rim scintillated on the edge of the absence, like the fat dreams that come before deep sleep. I was on a moon somewhere, becoming ice.

Without closing my eyes I passed for seconds or an hour outside the normal human orbits, under the snow-encrusted surface of the pond to the stillest, blankest observable territory in these parts. I slid across an empty, godforsaken whiteness and fortunately for my soul, recognized Europa circling Jupiter half a billion miles away. A place of uncontrollable cold, smooth beyond comprehension because it's wrapped in a frozen ocean, solid ice fifty miles or more straight down. Underneath is more water, not yet frozen, resting on dense, cold rock. For nearly eight thousand miles in a circle around Europa's equator there is only ice, unrelieved. Any hills or ridges slope very gradually to a few hundred feet at most. Europa is smoother and rounder than a billiard ball and stiller than an arctic lake.

I flexed my fingers in my gloves. This is winter. Beyond the mania of its three and a half day orbit, Europa's only activity is the creation of more ice. When its surface buckles and cracks, more water and rock fill the fissure and freeze. No one knows exactly how this happens. You might hear a crack like thunder explode the silence, and the ice might jerk and split at sonic speeds beneath your feet, and pressurized water flood suddenly into the crack. Or more likely, the ice warps as it does on the pond, with creaks and twists and throatless barks. Water then seeps in slowly from underneath and freezes in the –270 degree cold. Craters are erased by this process in short periods of time, say 30 million years.



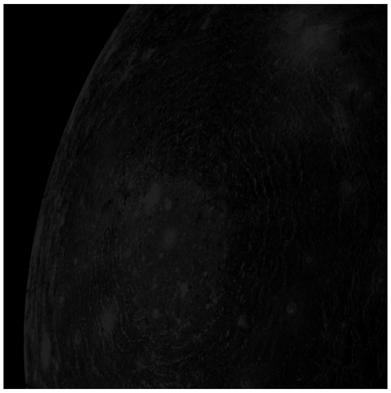
Otherwise there are no shapes or points of reference on Europa, no figures at all. Underneath the ice enormous lines criss-cross like Martian canals, but to someone standing on the surface they'd be invisible and wouldn't exist. There would be nothing to see or hear for millennia at a time, only the disk of Jupiter, four hundred and twenty thousand miles away, filling a sixth of the sky, illuminating flat, unending, polished nothing.

Survival here would involve the generation of motion in utter stillness. The excitation of molecules somewhere, at some innermost area which can hold out the cold. The real activity of winter is whatever supersedes the absence of warmth. On Europa the problem of shelter would concern not only the heat of your physical body but, the same as in Maine, your mind, which would be cooped in by the cold itself, not just the bad or absent roads. On Europa you would invent shapes and figures merely to survive. Your mind would seize upon a gloss of planetlit ice and thaw it into someplace else.

To be clear: Heat is motion. Temperature is a measure of molecular activity. Absolute zero is the total absence of heat energy, the temperature at which all molecular motion stops. This condition is abstractly represented on the Kelvin scale by the expression 0 K. On the Celsius scale it is –273. Fahrenheit, –459. It's difficult to imagine that kind of cold even on Europa, which is relatively warm at –270 Fahrenheit, or in Maine, whose winter is relatively warmer, though not much.

The cold is not the problem because you can always give in to it. You can always sleep, drift away toward death, when your energy subsides. You can extinguish much sooner than absolute zero; human beings seem to succumb to the stillness at levels of inactivity much more active than even Europa's. In Arctic Canada people do not go out alone when it's colder than –50 Fahrenheit. The core of what is human can solidify long before hell freezes over.

Even more difficult to imagine in deep cold is the survival of consciousness. On the surface of Europa, as on the frozen pond, consciousness would be simply the search for warmth, which is also activity. The moon-blankness is startling in a way, like the blankness of the snow-encrusted pond. The mind shivers at the thought of Europa. It's so cold, it's bright: It reflects sunlight and Jupiter-light with an albedo (or reflectivity) of .62, in astronomy-speak. The Earth, blue and white in space, has for comparison an albedo of .39. The Moon's is .11. Europa's surface temperature is on average lower than its neighbors' because it actually reflects heat away. Of the four Galilean moons of Jupiter, Europa and Io are in a warmer orbital zone than Ganymede and Callisto. In the strain and tug of Jupiter's gravitation, Europa is geologically active deep inside, pushing ice and rock slowly upward in a way that Ganymede and Callisto don't. Io is a different story. It is roughly as cold as Europa at the surface, but a place of volcanoes and sulfur compounds, a burning upper hell in contrast to Europa-Cocytus, lower hell. Triton, circling Neptune billions of miles farther on, is the coldest place in the solar system, with a mean temperature of –391 Fahrenheit. But even there, seasons lasting decades alter the surface ice, and



eruptions of nitrogen crystals blow through the tenuous atmosphere.

By contrast, Callisto, seven hundred and fifty thousand miles beyond Europa, is completely motionless. Its surface temperature is about –253 Fahrenheit, but nothing internal disturbs that surface, at any interval of time. Rocks inhabit its ice, and so it's dark, albedo .17. Callisto's cold, unlike Europa's, takes form. Instead of an absence of shapes and figures, on Callisto things rise up like monsters. Jagged craters cover everything. Most are small, less than ninety miles across, compared to those of other planetary bodies. Most are craters cratered with craters. Astronomers weirdly call these geographic features "palimpsests," as though the craters were trying to tell us something. One impact basin called Val Halla appears to be an enormous exception in size, with concentric rings emanating outward more than a thousand miles. But it too is webbed with smaller craters and has no ring mountains like those on the Moon.

The cliffs and small mountains of Callisto are older than Ganymede's and more motionless than Europa's ice. They loom like the monstrous shadows of frost. They seem to be the cold itself, frozen into shapes whose presence intensifies the absence. Apart from its inert, perpetual orbit of Jupiter, nothing is happening on Callisto. The meteorites that billions of years ago blasted out the craters lie in pieces the same as the night they hit. These are hell places. Whatever consciousness can survive here consists in isolated hills and shadows, and the disturbing fantasy that even Jupiter, which at some remote time might itself have shone like a star a thousandth as bright as the Sun, has ceased to pay attention. Its glimmering night-light passively reflects from Callisto's dirty, snowy surface. The dark mountain points and frozen impact escarpments form the shadows of abandonment. Even the Sun is too distant to move anything here.

Those frozen mountains are horrible. They are what you would see if you could somehow see nothing. Europa in its smoothness is in a sense invisible, rejecting everything, every attempt to locate anything. It throws all activity of heat or mind directly into empty space. Callisto outlines what a hole must be, sunken deep toward absolute zero. Except for its rock and ice, it does not, for all intents and purposes, exist.

* * *

Space contains our parallel worlds.

A winter night in Maine, like Callisto-night, seems eternal. The jagged spruce-tops in the woods beside the frozen lake point toward burning white crystals, like the mountaintops of Callisto. As I looked up that January night, the darkness seemed like an envelope sealed for good. Daylight would never arrive, warmth would never return. The entire universe for a few moments in the cold was eternally absent.

Winter is night and cold dissolved together. It is the living figure of all absence, and it brings all conditions of absence with it. It came to me that the Wabanaki and the red paint people, natives of Maine centuries and millennia before us Europeans, must have understood winter in ways impossible for me. They didn't think of bald Europas or Callistos, but instead moved with the season, entered it, maybe. When the cold had halted everything serviceable to life, the Wabanaki looked into the same sky as I do and called the bright full wafer there "Starvation Moon." The clams and mussels that were dried during summer had been eaten, and the deer and moose had all but disappeared. The bears slept, and nothing grew or even moved except in creaking wind and snow. Hunger, they knew from first-hand information, is a condition of nature. It is the living experience of nothing. It could not be defeated because it does not explicitly even exist, except in a figure of the changeable Moon. It could, given the right reserves of caloric and psychic energy, be waited out, the way the drowsiness before oblivion can be blunted.

I, on the other hand, shivering in the snow, knew the wood stove was warming the house. We have ways of preserving bodily heat during winter. But even nowadays in Maine, "cabin fever" is not an altogether figurative expression. Some people fail in winter. The cold grinds everything to a white smoothness. It slows the elbow joints and knees, and seems to freeze the afternoon itself, and evening, to a standstill. The Sun is absent fifteen hours a day here in the dead of winter, the Earth tipped over on its axis out of heat and light. Night enfolds the world by four o'clock. Feeling sealed off, like having claustrophobia in the darkness, people fray, their normal reserve and tolerance evaporate. A winter nervousness sets in that sometimes ends up bad, in fits of rage, or brawls, or worse, for all the world like psychic shivering. In winter we sleep at the edge of oblivion. The place of hell itself. The tops of spruce against the sky become ancient, inert mountaintops.

In times before the Wabanaki inhabited the Eastern Subarctic, a seed philosopher for modern Europe, Parmenides, pictured two ways of understanding the universe. One way was to think or realize that things actually do exist. To imagine for example Callisto and the Moon out there, with frost mountains. And millennia later to imagine, on one at least, latticed footprints undisturbed for the last twenty-six years and for twenty-six thousand more. The other way was to study or assume their emptiness. If we rationalize intently about Europa and Callisto for a time, we infer and – right on the edge of possibility, or its failure – almost perceive that they are essentially nothing, essentially void.

But no real information comes back from this way. Focus your mind on absence and things begin to freeze together and become indistinguishable. Pieces of facts, like inert meteor debris strewn around an ancient crater, can be heaped together, but the reality of Callisto or Europa, from this view, is their essential vacancy. You end up chattering about nothing. It's like shouting into an empty chasm and wishing for a rock slide. It's a wish for annihilation, like surrendering to the cold for a quick rest, and sleeping. A Wabanaki under the Starvation Moon did not rationalize the absence of meat or the emptiness of her belly. To visualize absence as though it were present reveals eventually the absence of absence, things exactly as they're not. Thoughts of what is not are thoughts of annihilation. Thoughts of annihilation are thoughts of hell, maybe.

The problem of winter is to generate activity, to excite molecules to warmth. The cold wants motion, existence of some kind, even a dream. Warmth is generated not by, but among the bare black crater-rims and frost. Not the motion gulped in by the eyes, which at the right depth will freeze over, but the motion generated in desire, which outlives starvation. The pure experience of cold is to inhabit it. Trees purify themselves by dropping leaves and draining sap, and enter January bodily. They neither succumb nor disappear, but occupy winter. There is no more ancient activity in the universe than the seeds of heat inside the cold.

The mind aligns the emptiness. It frames the snow and ice, and zero temperatures, and spruces which are little more than crater-edges. Black, empty space becomes eternally active. Seven crystals magnified in winter air are sisters, Pleiades. Three others are a hunter's belt. Seven in the north become a massive whirling bear. Europa's ice and Callisto's mountains are gateways into hell. Snow is a natural condition of April. Bark in the Adirondacks becomes food. The simple act of waking on a winter morning when the fire is out requires a mind of winter, seeing nothing that is not there, and the nothing that is. And minutes later, out of empty black space comes sunrise.

## EUROPA

Jupiter's moon Europa is covered with ice.

It's kind of unsettling to think about out there, circling silently around the giant planet in the middle of magnetic- and gravity-ridden space. It's white and almost as smooth as a cue ball. The ridges, pits, cracks and grooves in the ice rise and descend no more than a few hundred yards, which is about the terrain you'd find if you expanded the cue ball to just less than the size of our own Moon.

There is also a thin atmosphere of mostly oxygen, odd for a moon, or anywhere actually. It's thought to be formed from sunlight striking water molecules and splitting them into their two atoms of hydrogen, which is light and drifts away, and oxygen, which is heavier and stays. The unusualness of this is not the gases as much as it is the water that gives rise to them: Europa's ice shell is estimated to be fifty to one hundred miles deep, and underneath that is believed to be a liquid ocean.

An ocean beyond Earth? Apparently so, according to the findings of the Galileo spacecraft which orbited Jupiter in the late 1990s. The warmth that keeps the water liquid is generated through "tidal heating." The whole moon is twisted and flexed by the interacting gravity fields of Jupiter (whose gravitation is so big it keeps Saturn in line) and its other large moons Callisto, Ganymede and Io, and the twisting creates heat deep inside. Evidence of the heat are flows of ice on Europa's surface, not liquid rivers but ice that emerges from inside which is warmer than the dead-cold surface temperature of –260 degrees Fahrenheit.

There is a lot of scientific excitement about what that warmth might imply about Europa's underworld. If its inner ocean is indeed liquid then it's reasonable to wonder if life could have sparked and evolved in there. How anything could live in total darkness under ice fifty miles thick, no one is sure. But "extremophiles" – creatures living in environments fatal to the rest of us – have been found in very unlikely spots here on Earth, like in near-boiling water, in radiation that would kill a human, and in ice. Recently some NASA researchers drilled a hole in the Antarctic ice sheet and stuck a video camera down there to see what was going on with the water, when a three-inch-long shrimplike creature muckled onto the camera. It lives there under the ice. If things can evolve so they live under Antarctic ice, then living things might be evolving inside Europa.

These are just the cold, hard facts as the astronomers give them. Cold up to the point, anyway, where the possibility of something living inside Europa twists up your imagination and different kinds of fact-based excitement start bubbling into thoughts.

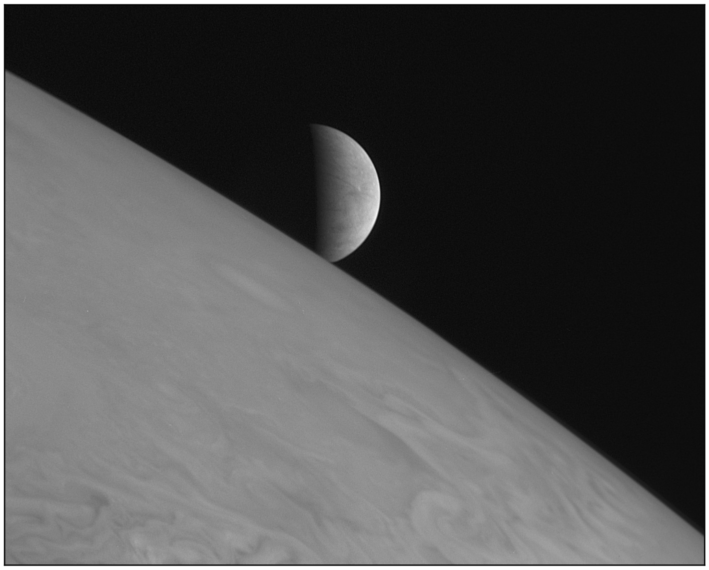
Wandering reflections on the possibilities of extraterrestrial life are fascinating, but can get kind of unsettling. Recently the eminent physicist Stephen Hawking warned that searching for intelligent extraterrestrial beings is risky because if they exist, they might not be friendly. So far, nobody thinks that any possible Europan beings are intelligent in our way of defining the word. If they exist, they're more like those shrimpisms, or much smaller. But really, how do we have any clue what's evolving under that ice? What unthinkable things right now, this exact moment, are twisting, furling and muckling in that frigid blackness?

An ice age ago back in college, I was transfixed for a while by the word "eldritch." I discovered it in H.P. Lovecraft's horror stories. It means "eerie" in the sense of unearthly, and might have evolved from an Old English expression we'd translate as "elf-rich" or "elf-realm," with a relation to the prefix al- which indicates "beyond," then transmuted itself through Scottish back into modern English. In his story "At the Mountains of Madness," Lovecraft's scientists go on an expedition to Antarctica and deep inside the continent they discover the ancient ruins of inhabitants from beyond Earth. Eldritch beings live there in the ice. Something wicked that way went.

Anyway, these are just thoughts wandering off and twisting around in the dark. We don't know what's out there in that cold.

We do know there are oceans within worlds. Not only Europa, but Ganymede and Callisto are thought to have subsurface seas, and also Saturn's moons Enceladus and Titan. They are all far, far away, circling around and around those huge planets in space that seems empty. It certainly seems like it's empty, just as Jupiter's moons and Antarctica did until recently. No wolves are howling on Europa, just silent, smooth, restless ice.

There are worlds within worlds, or so it has been observed for countless eons.


*Europa over a limb of Jupiter.*

# MARS

The bright, ginger-colored star that wanders into the evening sky from time to time is not a star at all – it's Mars. In the fall of 2005 we hummed past it roughly 43 million miles away, in one of the close encounters that occur every 2¼ years.

A closer approach of about 35 million miles in August 2003 was an opportunity to launch a spacecraft carrying people, but interplanetary travel got put on the back burner decades ago. Mars, nonetheless, has intrigued people for centuries, and longer, and in the mid-2000s NASA was directed to jump-start plans to send people there. Mars is an Earth-like planet, meaning you could walk around on it if you had the right equipment.

The surface of Mars would be strange to see. You'd clamber down a ladder from a spindly descent vehicle onto a rolling plain of red rock and dirt, as dead as any moonscape. The air, seen from behind a helmet, would be a faded orange color caused partly by reflections from rusty dust. The atmosphere is only about a tenth as thick as the Earth's, and so as you're looking out on the desert, a weird clarity magnifies everything, like the clarity that disoriented the astronauts on the Moon. Things are different here, though.

A boulder to your right seems nearby, but you can't tell exactly. You walk toward it. Your steps are light because Mars' gravity is about a third of the Earth's. By the time you get to the boulder, you have an idea of what thirty feet means on Mars. At an indeterminate distance farther out, a tiny whirlwind spins up some sand in a ghostlike funnel, then disappears.

Beyond, a hill with blocky rocks cuts a skyline. You think it's within walking distance, but you're not sure. The rust-red rocks jut up in a rough circle, like certain stone wreckage on English hilltops. Maybe holes are bored in the rocks, into which someone poured oil and then lit wicks, and crouched vigilantly watching the Martian desert.

This is crazy. They are obviously just rocks that have lain there for millions of years, visited only by wind, sand, sunlight and freezing cold.

But people have been wondering for centuries if there's life on Mars. The first realistic sketches of the surface were made from early telescope observations in 1659. In the 1700s the English astronomer William Herschel noted Mars seemed to have seasons and thought this could mean it was inhabited. In 1877 Giovanni Schiaparelli drew detailed maps including what he called "canali" – Italian for "channels" – interwoven over the whole planet.

The word canali was translated in the English press as "canals," which implied trenches deliberately dug and filled with water. Following this lead, the American astronomer Percival Lowell conjectured the canals were carrying water from the ice-bound poles to population centers. One of his students calculated the capital city of Mars was at 30 degrees south latitude, 90 longitude.

As it turned out, there are no canals. But space probes have indicated that water pretty surely flowed in torrents on Mars millions of years ago, and some of it is locked up in ice under the surface now. The main significance of this is that in the right conditions, water spawns life.

You'd like to hike across the rock-strewn gravel to that hilltop and look at those stones, which by now seem almost like archaeological artifacts. But Mission Control has other tasks for you.

Your boots are leaving latticed tracks in the sand. You look back toward the descent vehicle. Its sloping sides are covered in red dust kicked up by the landing. Its legs shine in the westering sunlight.

Across unmoving undulations of red desert is the horizon. The sun is lowering. The sky fades to a nasturtium color, and the rocks seem to grow in the twilight. The boulder's shadow bends across the rubble toward you.

You kick up some dust with your boot and watch it filter through the evening air and settle in your tracks. This sand could be full of the fossils of ancient Martian microbes.

Your mission is to find out.

## A WEATHER REPORT FROM VENUS

On hot, muggy summer mornings, nothing stirs. Heaviness is everything. When you wake up, the vast nowhere of the universe seems already to have coalesced and winked out. I remember July mornings in Maine so dense with heat I thought no bird or sound of wings would ever fly again. Even the lake a half-mile down the forest road barely gleams, it seems so dull and still and dead.

I remember mornings of coming to so slowly I'm not sure if I'm still dreaming or not. My head is so fuzzy no memories twinkle at all. In that kind of primordial heat even dreams are substanceless, or at best acids that dissolve everything, as if before the lead-gray sky and the stillness, you never were at all. After where I had not been, even sleep is a form of awake. I remember putting one foot unsteadily in front of the other and moving to the window and seeing dawn and the green yard. It's a pressure cooker. Everything motionless. If I could just start breathing in this humidity I could come to life.

Life begins not in spring but in midsummer when the rest of the world has been under way for eons. The planets circling untold billions of years in the sky, the stars careening still in their courses. From the window it seems something is happening beyond the leaden cloud cover. There has to be a way to punch through it or this is all going to collapse and return to oblivion so complete it obliterates sleep.

Wake up!

Somehow I move groggily from the bedroom down the hall to the kitchen. The legs are as stiff as the brain. I can't remember going out the screen door, like forgetting the moments you fell asleep. In the grass the mosquitoes are thick and vicious. They swarm up like mist from their nesting places under the blades. It's the heat and wet. Through May and into June, rain falls days at a time, and then comes bright hot sunlight, then more clouds, and the moisture never evaporates. Eggs hatch like crazy. Slablike clouds, made of who knows what, cover the whole morning and seal the landscape.

The bugs sting and suck, and this is really the first indication sleep is gone. Dreamlike images appear and disappear in the steamy air like blossoms and fruit, and after you slap four or five mosquitoes and smear your own blood on your forearm and cheek, you start to think you may not be on Earth at all. Hot summer morning biting and waking up are hallucinations of some superheated elsewhere you might inhabit like a fall into a potboiling book from which there is no escape, except to close it up, oblivion. This is not Earth at all. It's like the surface of Venus, looking up. You might escape from Earth awhile, you think. And then, horribly, you do.

In the beginning, hell goes everywhere you go.

A dull middle-dusk light gleams on Venus because the air is so thick. It's hot beyond tolerance, and the bloated atmosphere creates huge pressures. It's a hundred times denser than Earth's. Seeing on Venus is like looking through the chlorinated water of a swimming pool. There's more to heat waves than the illusion of motion, there's a twisted quality to every object, a depression in which a boulder looks like a pancake fried in a convex pan. Like the bent gray overcast of summer morning. On the surface of Venus, seeing is living on the outskirts of a cubist painting with images rounded inward and down.

The pressure to see on Venus what you see on Earth is tremendous, and this causes a kind of horror. The whole world is profoundly distorted, if you can stand the heat. The pressure of the cloud-plugged atmosphere does more than press, it oppresses, and oppression like this unravels with organic ferocity in lurid, chaotic hallucinations that resemble the burnt pastels of drug images. The whorl of pink, red and green in a rose bush which overwhelms the normal world and becomes a freakish monument of blood and joke, will, if it can stand the

$CO_2$, occupy a small concavity which your depth perception won't at first allow; you can't believe in this topography. Mountains degenerate to sea rollers and threaten to crush you with strange gray rock armatures and shifting quartz-like triangles that twist and crash in the atmosphere, gleaming. It is a hallucination of pressure.

The distortions of the visual surface gut and disintegrate the shapes of Euclid; on Venus, squares can not be imagined. This is to the Earthbound eye a horror beyond hallucination. The pressure is so great, the general theory of relativity seems to be at work, light itself is bending, you think, it's passing through colossal gravity like the Sun's. But it's merely sunlight filtering through clouds of sulfuric acid. The flat lakelike twinkle overhead seems immense, though Venus is about the mass and size of Earth.

Though it is not the same. It's impossible to know exactly what a temperature of 800 degrees does to your vision, and what that vision did to your soul. I keep thinking a surrealist painter like a sleeping alter ego went there and back and could not talk about it, and these are his images, limited to the dimensions of his own capacity for horror, which to us are simply figments of topology. The surface of Venus is devoid of granite boulders. Instead it is a causal interconnection of sight and object, imagination and oppression – a maple tree on Venus would grow like an anemone and send out nervous tendrils in the steam, across an acre of crushed uncertain rocks; an observer would see and understand the squalor and derision all at once of being made of heat and smog and leaden mist.

It is not fair to speak of topography under such pressure. It isn't even fair to say topology, though it amounts to this. The topology of Venus is what's important, because while the topology is somehow knowable, somehow representable, the topography is not. Uncertainty devolves from uncertainty, surrealist predictions are simply formulas that seem true to the phenomena, and the phenomena are the lightning bolts of all the artist knew and felt. Everything is interconnected when he looks across the heat of the planet. It's similar to psychosis, like being in love.

Like love, it is a self-contained dream: The heat of Venus has little to do with the Sun and everything to do with itself, folding its gases into itself and cooking. Its languid winds cause ripples in the mist and cells of compacted air travel slowly from north to south, south to north. It spins, I am horrified to report, from east to west, almost as surreal as Uranus. The topography, or topology, or geography of it is a mutation in a dream, and even the artist cannot describe the nightmare he has alone that morning. The pressure then requires some overt activity, and this is the difficult thing, the incredible thing, because motion in this swamp must be impossible: How do you move through objects which do not keep still, or even if they're still, do not behave correctly to your vision?

You move the way the painter moved, like the maple-fantasy that grows, perhaps, from the triangular gravel. Your footstep is the same as the interchanges of nature (and by that I mean the flow of life to death, oblivion to consciousness, and back again). It becomes the weather-heavy shreds of carbon breezes and twisted knoll shapes. You can only move like twilight, which is a way of saying Venus typifies your love affairs. Your motion is the motion of the planet itself, not like the motion of the Moon which is dusty, arid, airless and therefore dead. There is no weather on the Moon like Earth weather, with slabs for clouds and alternating sunlight and rain. But on Venus the weather is a vast compression of your eye, your ginger footstep, and a nightmare simulacra of the motion of spring into summer, unbelievably hot. The loneliness of this kind of love is oppressive. Somehow activity on the surface of Venus becomes a river of smog and sulfur, cut off from the rest of creation like a rhyme lost in a dead man's mind.

The veils lift one by one and settle in the early morning stillness again. Here on Earth, fortunately, things grow everywhere, in the neatly trimmed edges of the lawn, beside the cedars we love. For now the vegetation burgeons in the heat and damp. Air made of carbon dioxide is rich to a pine, though the clouds of early morning still oppress and flatten everything and force a comparison you never before could make because you weren't awake.

Mosquitoes plow up out of the blades of grass to feast on your blood. Breezes twist the leaves of silver maple. The neighbor screams at her dog. Hot summer, the smell of lilacs, small armies of kids wrestling in the yard. Rain threatens.

In a small telescope with a good filter blocking out upwards of ninety-nine percent of the visible light, the Sun looks like a big orange ball. There is not much to see, really. The orange ball is very round, sometimes with a few sunspots scattered here and there. Sunspots are small, dark, roughly circular patches, sometimes butted together. When your eyes get adjusted to finding the finer details, you can see that the sunspots look like wide-mouthed volcanoes, with very dark centers and lighter-colored surrounding areas that are easiest to represent in a drawing as lines sloping or swirling out from the center. Supposedly it's possible to see flares and prominences on the active surface of the Sun, but I've only seen sunspots.

A sunspot is a cool area. "Cool" seems like a strange word to use when describing an object which is for all intents and purposes in a perpetual state of thermonuclear fusion. A sunspot's temperature is about 4,200 degrees Kelvin, while the visible surface of the Sun, which is called the photosphere, can be as hot as 6,400 Kelvin.[6] Galileo in the early 1600s was the first human being to invent a solar filter and see sunspots on the Sun's surface. The fact that the Sun had imperfections was a matter of profound cosmological concern to everyone, although of course neither Galileo nor anyone else had any idea what a sunspot actually is.

A sunspot is a manifestation of a disturbance in the Sun's magnetic field. Even in the small telescope you can get a sense of the photosphere's granular appearance, created by fifteen hundred-mile bubbles of hot gas that continually seethe up, cool off, and then retreat. The magnetic field pops up from some unlocatable place inside the Sun and disrupts the granules, making these dark patches. Sunspots occur in larger and smaller numbers over eleven-year cycles, suggesting there is a cyclic activity to the Sun's magnetic field. Twenty-three cycles have been monitored.

The Earth is affected by sunspot activity. Sunspots are associated with "solar flares" which blow off energy that often reaches Earth, ignite auroras and can disrupt radio communications. From 1645 to 1715 almost no sunspots were noted by a astronomers following Galileo's lead, and this quiet period corresponds to the Little Ice Age, when Earth's average temperature dropped about .5 degrees Kelvin, and researchers believe there must be a correlation. Some studies have suggested that periods of human creativity correspond to times of sunspot maximum. This begins to sound a little like astrology because it's on a boundary where definite, scientific causation leaves off and indefinite possibilities begin. Nonetheless, it comes to us from the application of scientific method. The activity of the Sun apparently bears some relation to the activity of the human mind.

Interestingly, astronomers talk about the Sun in general categories called the "Active Sun" and the "Quiet Sun." The Quiet Sun refers to all those facts about the Sun which are relatively stable. For example, at the Sun's core thermonuclear fusion is steadily turning hydrogen into helium, creating unfathomable heat. The temperature at the core is about 15 million degrees Kelvin.[7] Heat radiates up from the core through the radiative zone. (Radiation means heat energy is transferred from place to place at the atomic level, by electrons.) The temperature decreases through the radiative zone until it reaches a convective zone, where the heat is transferred by convection, that is, by currents of hot gas moving up, cooling, then settling again, until the heat energy reaches the surface, or photosphere.

No one has ever looked directly into the interior of the Sun, and so the core-radiative-convective structure is inferred from conditions on the surface, as observed through telescopes and other instruments. The inner atmosphere just above the seething visible surface is called the chromosphere. The chromosphere is still a quiet aspect of the Sun, even though things become a little strange here (as though the conversion of 4.5 million metric tons of matter per second into energy were something humanly ordinary). Because the photosphere's visible emissions are so powerful, the chromosphere is essentially invisible, except in the moment just before and after a total eclipse of the Sun, when it becomes visible to the eye as a bright pink or red flash. In scientific terms this flash is called a "hydrogen-alpha emission," or a particular wavelength of light generated from a transition of hydrogen from one atomic state to another.

The chromosphere extends into a transition region of the Sun's atmosphere, and beyond the transition region is the corona. The corona is the familiar flaming blaze around the Sun photographed during total eclipses, the only times when it is visible. In the transition region there is a sudden increase in temperature which continues through the corona. This is particularly strange because common sense, even in science, would suggest that the farther you are from the source of heat (the fusing core), the more heat energy would be lost, and therefore the cooler the temperature would be.

But outside the Sun, it's the reverse. The temperature increases slightly, from the photosphere through the chromosphere, and then leaps in just a few hundred miles to about 1 million degrees Kelvin in the transition region and the corona. Apparently astronomers are not sure exactly why or how this happens. The word "paradox" occurs in at least one discussion, and it is generally thought that, in the words of the *Encyclopedia of Astronomy and Astrophysics*, "the photosphere heats the corona from the nonthermal source of energy stored in its magnetic fields."

At this point the discussion becomes a bit uncertain for non-scientists, and indeed the encyclopedia's next sentence begins: "Two mechanisms are thought to be involved." Apparently it is a bit uncertain for the scientists, as well. It has something to do with magnetic fields, again, which are not thoroughly understood.

In fact no one has ever observed a magnetic field, only its effects. The Sun has an internal concentration of charged energy related inextricably to its physical mass; this is its magnetic field. The magnetic field is the area of space where magnetic forces are exerted on physical bodies. The forces exist where the connection between energy and matter becomes tangible, like two magnets attracting or repelling each other.

In the Sun the tangible connecting points run north and south in lines. But the Sun rotates at different speeds, faster at the equator and slower at the poles, and so the magnetic fields twist and bend like rubber bands. When, cyclically, the magnetic lines twist too far out of shape, the tangible meeting point of energy and matter becomes disturbed, and the lines rip through the photosphere, blasting holes in the granulation and looping back together, so to speak, at footpoints. Sunspots appear, and other things invisible to the eye occur outside the photosphere. These unstable events are categorized under the phrase "Active Sun."

Sunspots are active because they come and go sporadically, if cyclically. Solar prominences occur when clouds of hydrogen gas are suddenly ejected from the photosphere, usually in the vicinity of sunspots. Solar flares are violent eruptions of energetic particles and electromagnetic radiations from the magnetic storms (analogous to thunderstorms) occurring at sunspots. It's the flare from the sunspot which discharges energy into interplanetary space and creates magnetic and radio disruptions on Earth. Coronal loops and arches are also associated with the magnetic field.

The Sun seems to be continually escaping from itself, burning hydrogen in its core and sending energy outward by radiation and convection toward the surface. At the surface it somehow gains strength and radiates tremendous heat, enough to warm the planets, and sends prominences and flares outward as though grasping in some ecstatic and largely invisible desire to illuminate and emerge into the atomic universe of space-time. We notice it only during an eclipse, in the second before the Sun goes dark and the chromosphere appears as a flash of red light, and in the moments when the corona glows in visible flames around the black disk of the Moon, if our filters are efficient and our instruments are delicate enough.

* * *

These bald facts capture the attention because they seem so far outside the range of normal human experience. The concept of enormous ongoing nuclear fusion, unfathomable temperatures, sheer size (the Sun has three hundred thousand times the mass of the Earth), the idea that the Sun's luminosity[8] is so overwhelming it is blinding to the unfiltered eye – all these facts are, from a certain perspective, awe-inspiring. The very idea of a "magnetic field" becomes downright mysterious.

A detailed description of a magnetic field involves a description of the activity of electrons, and a description of the activity of electrons is inferred from the abstractions of mathematics and the indications of elaborate detecting instruments. In a very real sense, no one has the slightest idea what magnetism actually is or consists of, apart from the fact that it operates in very precise mathematical ways. Describing subatomic activity creates no more of a sense of reality than does describing the effects of 15 million degrees. They're both out of direct human range. Really, the Sun is as mysterious as it's ever been. The idea that it has a core, a radiative zone, and a convective zone is no more plausible or believable than the idea that the mind has an unconscious zone and a conscious zone. Both ideas are so useful in describing what is directly observed that they are spoken of as essentially proven, but no one has ever seen or laid hands on "an unconscious" or "a core."

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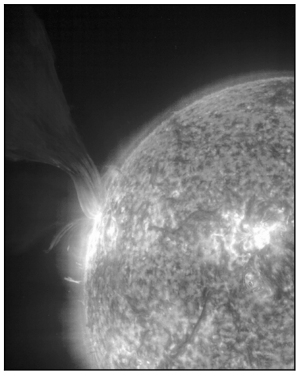


The whole mass of scientific information seems analogous to the filter on a telescope. The Sun and many of its processes are clearly understood through abstractions about electrons and magnetic fields, the way the dull orange ball is clear and precise in the lens. But at times when I step back from the eyepiece and squint for a few seconds into the blazing white radiance overhead, sudden tears and a slight headache behind my eyes permanently dissociate the clean orange circle from the blinding whiteness. Some radical intuitive intelligence, in those moments, loops up out of the mass of data and announces that the filtered orange image of the Sun is not the Sun. Science's clinical descriptions of the Sun are as remote from our experiential reality as the ancient myths of solar divinity.

What is the Sun, if not an orange ball or a mass of inferential and mathematical abstractions? Johannes Kepler, for example, would find the mathematics of magnetic fields astounding, yet he would not take the subsequent inferences for a description of reality, per se. For him reality inhered in neither inert matter nor the behavior of inert matter. Kepler, essentially a Pythagorean, began with the idea that the material universe reflects divinity: The Sun was not simply an empirical example of what Newton later called "lucid matter," but a living symbol of divinity.

For Kepler, God is like a point, and the point radiates outward in infinitely many directions, like lines forming, in one plane, a circle. "The centre flows out towards infinitely many points of the whole surface," he says.[9] If the third dimension is added to this image, the radiating, infinitely-many lines form a sphere, which is the perfect shape of the created universe described in Plato's Timaeus, and elsewhere. The "circle is to the sphere," Kepler says, "as the human mind is to the Mind Divine, that is to say, as the line is to the surface."

The idea of the central point's outflowing or radiating extends naturally to the most prominent object, perhaps, in the physical world: "The sun is a certain body in which [resides] that faculty of communicating itself to all things which we call light. For this reason alone it is the middle point and centre of the whole world, so that it may diffuse itself perpetually and uniformly throughout the universe. All other beings that share in light imitate the sun." The Sun, in other words, is a natural symbol of the Divine Mind of God: "The mind is both inherent in the body, informing it and connected with corporeal form, and sustained by God, an irradiation as it were, that flows into the body from the divine countenance."

This is reminiscent not only of Plato, but of Plotinus, whose highly technical metaphysics in the third century A.D. mapped out a similar metaphor, in which Nous, or Mind, is the first emanation of the central unity of the cosmos:

> There is ... something that is centre; about it, a circle of light shed from it; round centre and first circle alike, another circle, light from light; outside that, not another circle of light but one which, lacking light of its own, must borrow ... all begins with the great light, shining self-centred; in accordance with the reigning plan (that of emanation) this gives forth its brilliance ...
>
> (Plotinus, *Enneads*, IV.3.17)

As citizens of the scientific universe we might think that Plotinus' image represents the primitive intellectual struggle of a great mind with too few facts. And we might think poor Kepler's vision is still obscured by religion and Pythagorean superstition because he lived, unfortunately for him, a few hundred years too soon. But at least in these versions there is a connection between the human mind and the central radiance: Kepler's symbolic mind is inherent in the body, and Plotinus' outer circle (which represents material reality), lacking its own light, borrows that of the great light. The individual mind, in other words, is an outflow of a central mind, or central point. We all somehow, as Descartes suggested, directly experience our own minds, and so thinking of mind as light and light as a radiant outflow connects the individual mind with the Sun, even though we stop short of thinking of the Sun as God. In symbols, reality touches the mind.

* * *

In his later work the *Harmonies of the World*, Kepler's main premise was that the world, or universe, is a living expression of the Divine Mind, or God, and his project was to show the mathematics which reflect the harmonies inherent in that Mind. Book V, in the painful and lugubrious detail typical of Kepler's work and writing, shows how the planets in their orbits describe the harmonic intervals of music, and he means that there is a harmony of sound constantly proliferating through the universe (which he, and everyone else, believed was constituted chiefly by the Sun and planets). This harmony is the natural expression of the perfection of God.

To us this sounds like wishful thinking, what one prominent modern scientist, ridiculing the idea that the universe looks like it has a design, calls "that age-old pitfall of Western intellectual life – the representation of raw hope gussied up as rationalized reality." Stephen Jay Gould in his essay, "Mind and Supermind" speaks with the voice of scientific conscience, here, and we are honor-bound, as intelligent folks in the twentieth century, to heed his authoritative warning. The Sun and planets are not playing music, and even if they are, it is an accident. You can see what the Sun really looks like, by the way, through a properly filtered telescope.

Except it is not so simple. The Sun, it turns out, really is playing music. Astronomers have noticed, in the Sun's photosphere, oscillations with periods of about five minutes, growing and dissolving over half an hour. This implies that seismological activity inside the Sun's convection zone triggers vibrations that create sound waves. In actuality millions of tones are all ringing together like millions of solar bells, and if you invented the right receiver and amplifier, you could listen to them.

This solar music can be dismissed as an accident of the natural laws of physics, which them selves must be accidental consequences of the Big Bang. This is Professor Gould's view. But Kepler's approach – from abstraction to objective detail – and Gould's approach – from objective detail to abstraction – both contain a fact of reality: Celestial bodies generate music. One may legitimately wonder where accident and coincidence leave off, and apperceptive and noetic processes begin.

* * *

Wolfgang Pauli, like his peers Neils Bohr, Werner Heisenberg, Erwin Schrodinger and David Bohm, was intensely interested in what the findings of quantum physics implied about reality. In his essay on Kepler, Pauli suggests that the powerful universal symbols which Jung called "archetypes" have an actual objective existence, and that they serve as the bridge between sense perceptions and ideas. The human mind, in other words, meets the universe in symbols. Symbols are real.

A symbol is an extended and deepened version of a metaphor, like a circle dimensionally unfolded into a sphere. And a metaphor, in simplest terms, is an identification of one thing with another thing which it apparently is not. For example, Kepler's sphere is identified with the universe; the universe is further identified as the outpouring of the Divine Mind. Since in geometry the point is the origin of the line, circle and sphere, it therefore is identified metaphorically with God. In this way the point is very nearly identified with the sphere as well, because the universe symbolizes the Divine Mind, which is to say, God. All things are identifiable, or connected.

The Divine Mind, Kepler continues, in giving rise to a circle gives rise to other minds. The other minds or – and we can safely substitute this word, here – souls are structured like their originator: Each soul is

> a point in actuality ... and the figure of a circle in potentiality. Now, since it is energy, it pours itself forth from that punctiform abode into a circle ... How should [the soul] have any other way of going out, being itself both light and flame, than as the other lights go out from their sources, that is, in straight lines?
>
> It goes out, then, to the exterior of the body according to the same laws by which the surrounding lights of the firmament come in ...

Pauli connects Kepler's circle imagery to Jung's theory that the mandala of eastern religions represents the wholeness or total quality of the mind. "One is tempted to assume," he says, "that Kepler's 'mandala' symbolizes a way of thinking or a psychological attitude which, far transcending Kepler's person in significance, produced that natural science which we today call classical. From within an inner centre the psyche seems to move outward, in the sense of an extraversion, into the physical world in which, by definition, everything that occurs is automatic; so that the mind, itself in a state of rest, embraces this physical world, as it were, with its ideas."

Like the apparent connection of sunspot activity with periods of human creativity, figurative reasoning like this seems suspiciously astrological or occult. Pauli, however, was not a crackpot, but one of the major contributors to the interpretation of quantum physics, which is presently the dominant physical model of the universe. Pauli is led to speak of activities of the mind as "reality" because in various interpretations of quantum theory, it's clear that human consciousness plays a role in how reality develops.

Consciousness is one element, at least, in the overall pattern of objects and events which we term "reality." Pauli is saying that consciousness is indeed, as Kepler detailed, like a point which outflows and embraces or participates in reality with ideas. The activity of the mind is real and actual, the way the activity of the Sun, as we empirically understand it, is real and actual.

In fact, consciousness itself describes circles by embracing and participating in its surroundings and forming itself into works of various forms and qualities – ideas formed in language, communities formed in moral, social and political structures, images formed in paints. And there is the further sense that consciousness from time to time transcends itself, boiling momentarily out of its routine surface and disappearing into some invisible yet dynamically active world which is normally , except under exactly the right circumstances, inaccessible to us.

Plotinus tells us it has happened to him many times: "Lifted out of the body into myself; becoming external to all other things and self-centred; beholding a marvelous beauty; then, more than ever, assured of community with the loftiest order, enacting the noblest life, acquiring identity with the divine" (*Enneads*, IV.8.1). This is not the world of Stephen Jay Gould, but it is a world nonetheless, alive and supernally active in the mind.

* * *

What the mind is, concerned Plotinus at least as intensely as it concerned Kepler or Jung or Pauli. In fact, in Plotinus' scheme Mind is the first reality of the created universe. In science, Freud's powerful trope indicates human beings have two minds, the conscious and the unconscious. The general idea is that the unconscious is the brain's vast reservoir of information, process, memory and function, and the conscious is the brain's notice of the surface of that reservoir, observing and using whatever bubbles forth, either summoned or unsummoned.

Commonly we think of the unconscious as a depth which can and should be plumbed. We have an almost archaeological attitude toward the unconscious, diving down through layers of memory in one part, or through varieties of emotion and intuition in another, bringing back strange figures, half-formed thoughts, and inchoate or broken sensibilities gained no one knows where.

Powerful ecstasies and terrors are thought to reside in the unconscious; it is thought to be extremely dangerous to dive too deeply there without guidance or at least a buoy to connect with the real world. History is filled with – and probably has failed to notice – thousands of those who lost their minds in their own minds, not the least of whom (let us defer to the possibilities of Professor Gould's accidental universe) were perhaps Plotinus and Kepler. Mistaken and crazed – divorced from the real world – by the fantasies of their own unconscious minds.

But the minds of Kepler and Plotinus seem to have gone out, rather than in: Plotinus speaks of being lifted out of the body, Kepler of an energetic soul pouring itself forth, and Pauli speaks of the mind as embracing the physical world, as though the embrace was a literal event rather than a metaphoric description. By the time of Freud and Pauli, the metaphors of science similarly take on an eerie life of their own, as though the metaphor was more real than reality: The mathematical equations are more immediately real than hydrogen atoms, which are thought to fuse in the core of the Sun and send electrons to radiate outward from the center, none of which human beings can experience or even observe. “All things,” concluded the Pythagoreans, “are numbers.”

We believe the interior of the Sun is profoundly active, as a matter of fact, although we describe it as quiet, the same way we believe the unconscious mind to be profoundly active although it is invisible. Heat radiates up from the Sun’s core the way thoughts bubble up from the unconscious. Hot gas moves through the Sun’s convective zone, cools and settles, and repeats the process until the energy reaches the photosphere and churns the surface. In the same way, memories, for no visible reason, appear on the surface of the mind and then subside like pockets of wind riffling and blackening a pond, then lifting to disappear in the trees.

Inside the mind – which we could say is (for the sake of elucidation) an extended, deepened, dimensionally unfolded version of the Sun – tremendous energies function. Old emotions emerge from memory to tear open the conscious present, as though powerful convections pushed things up and outward, then pulled them back. Far down inside the mind, driving the unconscious, are the engines of life itself. At a central point or core, the mind fuses the original elements of itself into other elements, the way the Sun, and the universe itself, fuse and derive themselves from hydrogen. The fusion creates tremendous energy which is the life of the whole body. It streams outward and upward, radiating electron-flows of heat from one point to another in all directions of the outer regions.

Further from the center the heat is less, and its flows converge in little vortices, like currents of water converging in whirlpools. Eventually there are millions of convergences, galactic shapes shuffling and inhabiting the mind. They cool and gain cohesion, grow larger, transforming into individual figures, like pockets of hot gas or like flows of air assembling into hurricanes. Like gases they heat and rise, cool and sink again, transferring their energy upward. These are the archetypes building the interior mind, as natural as weather itself, or as moving water, or as convection. They surge together, collide and rearrange themselves like spiral systems of stars, exchanging, assimilating each other, feeding and slowing each other's whirl and fluid motion.

Finally they rise intact and burst like springs of water or as pictures on the surface of the mind. They feel at this conscious point like whirlwinds circulating dust and leaves, or hurricanes roaring over the ocean, raising gray triangular waves and smashing boats and houses over rocks and flooding streets and buildings. Then subside from sight, like the conscious mind generating, trying and casting off or adopting realities constantly. Here at the surface, where the turbulence is apprehensible, is consciousness.

It looks granular, with individual bubbles and whirlpools gushing up, but continuous, like the photosphere of the Sun. The granulation seems serene, normally – the largest upswells are not much bigger than the others. The surface of the mind is a granulation of thought and image, idea and feeling, and seems quiet because it's so normal.

The unconscious mind, in a peculiar way, seems most active despite its invisibility, the way processes of fusion, radiation and convection inside the Sun seem active compared to the quiet orange photosphere. The idea that nuclear fusion is at the core, and only bubbling is at the surface, suggests the real activity occurs at the point of generation, and the surface is a rest from violence. What fusing images inhabit our psyches but never emerge at the surface?

The limitations of our own vision, which sees only the surface, are all that differentiate the conscious from the unconscious. The two minds are the same thing. Ideas emerging in consciousness occur simply at the edge of underneath, and are different only by location from those that stay submerged; they form the visible granulation on a burning sphere of rising and settling bubbles. The conscious and the unconscious are no more separable than the photosphere and convection zone of the Sun. Simply, one is visible and one is not.

The quiet mind is what Plotinus meant when he spoke of “light from light.” The steadiness of sunlight, generated inside the Sun and pouring outward to us, is the material nurturer of our physical reality; without it we’d be cooked, either never given time to evolve because of fluctuations of heat and cold, or burned in a sudden flash. Many stars are variable like that, after all, and the Sun is in the end a benevolent star among billions of billions of stars. The quiet Sun fosters life, irradiating steadily outward from its core to its surface to its atmosphere to the planets, and, twinkling, beyond them. The mind in its creative phase nurtures reality in the same way; it embraces the world with ideas that bubble through the surface and light outward in lines.

But the whole mind is rarely entirely quiet, as the Sun is rarely entirely quiet. There is constant activity and frequent disturbance. Things that are intensely raw boil from the mind. Emotions explode with tremendous violence at times, and powerful thoughts erupt as if from nowhere, throwing off energy in spikes and loops and sometimes turning the embrace of the conscious mind into a flood of radiative energy, transforming the shape of the universe. The thoughts of Christ or Newton affect other minds the way high-energy particles spur auroras.

This is the active mind. While the core quietly radiates heat and energy outward, in the interior the connecting-points between matter and energy generate activity. The mind, exactly parallel to the Sun, has an internal concentration of energy related inextricably to its physical mass. This is its magnetic field. The agitation of the body can disturb the mind the way the motion of the Sun disturbs its magnetic fields. A self, which exists where the connection of body and mind becomes tangible, struggles and surges normally against the impositions and appetites of the physical world like the magnetic lines of the Sun twisting and bending against the physical rotation of its gases. The lines themselves twist out of shape and out of unity and harmony with the inner processes. They bend and press in different directions, like different impulses of instinct and rationality, or fear and calm, or feminine and masculine pressing and entangling each other rather than staying whole and integrated. As they torque themselves to resist or adapt to the body's commotions, the mind realigns or agitates or disrupts the convections of the unconscious, and storms erupt through the conscious surface.

The active mind conjoined with the body constantly influences its surroundings. It radiates, convects and sometimes ejects material outward, so that the area around it is constantly transformed into buildings, homes, governments, relationships. The mind irradiates its surroundings. Its chromosphere and corona exert themselves compulsively outward, gripping the physical world in activity much more intense than the conscious mind is aware of. "Everything which is caused," says Dante, "is the effect, mediately or immediately, of some intellect." The mind's energy leaps radically to transfer itself to the universe.

This outer atmosphere of the human mind is neither conscious nor unconscious, neither interior nor superficial. The surface of consciousness is only a thinness over an interior. The radiant mind illuminates everything, the way the Sun pours streams of particles and energy Earth-ward to bathe the atmosphere, create auroras, disrupt radio communications and surround the Earth's magnetosphere with light.

In rare instances, the everyday mind extends itself beyond its normal range. When the force of habit is from time to time obliterated, as the Moon from time to time obliterates the normal sunlight, spicules and prominences appear as sudden illuminations, like the flashes of red light and effulgences of coronal sunlight revealed in an eclipse. Like the vision of the chromosphere around the Moon's black disk, the mind's whole irradiation emerges to awareness. In a moment of eternal contact, the mind experiences itself unfolding beyond its granulations into the universe, and enfolding itself into the deep being of space. Plato, Plotinus and Dante saw this vision, like emerging from a cave of shadows into blinding daylight. As if enabled, suddenly, to look at the unfiltered Sun.

It is an illumination as inexpressible as music, which is generated deep in the mind and also understood there where all tones are a single diapason, inflowing and outflowing together. It is invisible to the eye. With filters astronomy as a matter of course detects the strange array of Sun-born particles and waves of light and even infers musical tones, the way psychology, with absent-minded recourse to the unconscious, explains calamities of consciousness. But scientific instruments do not reveal the meaning or beauty of a chord. The burning corona of the mind is the superconscious, the flowing-out which embraces reality. To plumb the depths of the unconscious is to excavate the structure of the self, but to stream outward like light and flame to grasp the world is to inhabit and coincide with reality. It is outside the limits of the seeing eye, and beyond comprehension.

Lifted out of itself and streaming into the universe, the mind in a flash experiences itself as its own Sun and solar system, simultaneously self-centered and external. It makes and is and is made by its surroundings, and acquires identity with everything. It travels outward, as the solar wind after its ecstatic burst travels outward past the planets and through the cloud of comets, carrying electric and magnetic fields to the heliopause, and meets the cosmic rays and magnetic field of the galaxy.

And the surrounding lights of the galaxy, hundreds of billions of them tens to tens of thousands of light years away, stream in as rays of light and wind generated exactly the same way. Exactly as and with the Sun they formulate the deepest reaches of space by filling it with radiation, light. Every star is a Sun, some huge and red and middle-aged, others small, crumpled and ancient, and still others new and blue and roaring hot with mind-material flowing out in flame and light.

*So great is God that his very members are infinites*

* * *

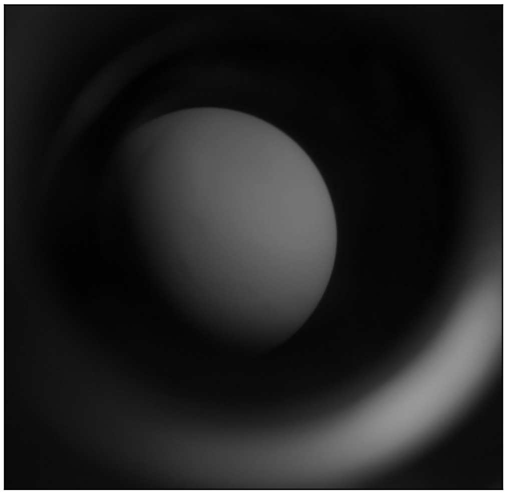
Lucid matter, observed Newton, like that of the Sun and stars, radiates its own light. Non-lucid matter, the other kind, does not radiate its own light. It is a reasonable division to make and in a figurative sense still applies, since Einstein demonstrated convincingly about ninety years ago that matter is energy. The Sun and stars are built of lucid matter.

The forces that build lucidity out of inert mass are, despite the best equations of math and the most delicate observations of science, not directly known to us. Particles seem to spiral together like fluids traveling in opposite directions and joining to form a vortex. Atoms converge first, like stray images bubbling up in the mind, and then molecules, like words or clusters of words, coagulate on the image, and soon a mass exists, inert but in motion. When the mass is a suitable size, it begins to burn and radiate heat and light, becoming lucid.

It is commonly thought that Newton's and Einstein's minds were among the most lucid of any in human history because each re-invented our conception of the physical world, primarily with mathematics. Newton also spent the last twenty years of his life detailing the numerological symbolism in the Bible.

The Sun is not a discrete, accidental orange ball at the edge of a whirlpool of billions of other discrete, accidental balls. It is, in reality, a living symbol of how the universe precisely and carefully enfolds itself vanishingly into itself, as stars move in galaxies, planets move in solar systems, electrons move in atoms, archetypes move in minds. We can no more hope to understand this by viewing it objectively from afar than a grain of sand can hope to understand the desert by trying to view the desert floor. “Science with patience,” wrote Rimbaud; “The torture is certain.” The grain of sand is the desert.

The human mind inflames the universe, like the Sun. It contains the Sun, knows itself by the Sun, and in the most real sense it is the Sun, flowing into the universe like a wave, engendering meaning as moving water engenders vortices. The true pilot of the self, in Plato’s metaphor, is the mind and an astronomer. The Sun, it has been observed, is a morning star.



# SPACE-TIME

## FABRICS OF TIME

One of the stranger unforeseen things about growing old is the weight of memory. And by that I do not mean the memories of pain, though remembering bitterness and grief is heavy enough. Instead I mean the sheer mass of details. The more information accumulates (and there are more details every second), the harder it is to keep it in order and its weight balanced.

For myself, I've always tried to keep a pretty strict tether on my time line. To my mind, certain events serve as points of orientation like bright stars in a constellation: in our fifth-grade classroom, the news of John F. Kennedy's assassination; a sunny June day in 1971, high school graduation; in the spring of 1974 and of 1980, first and second readings of Dante; October and November 1977, a lone hitchhiking tour in England, Ireland and Scotland; 1980-81, a winter on Munjoy Hill in Portland, Maine, of emotional turmoil, poetry, and rock and roll; in July 1988, the moon over Warden's Hill in the Northumberland midnight twilight; 1:40 p.m. January 29, 1991, the birth of my son Jack; August 1995 to June 1997, a sojourn in Eastern Europe; a year and a half in China; and so on, events pinpointed in moments and stretched over lengths of time.

Not so well-tethered are a lot of the small details. I mean, most of them. They're almost all lost. But some are recoverable in the mind's eye. Some few events or places from twenty, thirty, forty years ago can be revisited with the same patience you use to look at a planet through a telescope. With concentration, details start coming into focus that otherwise seemed invisible or lost: a hedge with rose hips looking like jesters caps beside the cobalt blue of Casco Bay one late-August day in 1985; a two-legged leap in the air with a wailing guitar on the stage of a downtown bar in 1981; a box full of paperback science fiction novels in 1968, I can make out some of the titles on the spines, like spotting streaks on the surface of Jupiter; the worn hardwood floor in the recovery room of a children's hospital in Hong Kong where Jack had a minor procedure when he was nine years old.

And so on, on and on. Because of the bright points of orientation, I know when those things happened. But many other images and feelings have only the vaguest location in time: When did the ancient tree standing alone by the sandbar at Little Chebeague Island first burn itself into my memory? When in the 1970s or '80s did I realize it was an oak tree and not an exotic rainforest hardwood?

How many faces have I looked directly into in North America, Europe and Asia? Sometimes the images of good friends from decades past pop into view, and the sight is painful because I had forgotten them. How could the guy I hitchhiked up and down roads all over central and southern Maine with in 1974, have disappeared from sight? Stood beside a cow pasture and a rail fence for hours humming a Steely Dan song – no, that happened three years later, deep in the countryside of western Ireland, thinking I'd never get a ride.

Time arrows along, but somehow is not completely linear. Emotions, especially affections, resonate together across stretches of time and connect isolated events into whole periods like personal epochs. In those recollections of a summer or of a couple of years, time begins to feel less like a relentless river and more like a fabric. With age the fabric starts to feel like a patchwork. Most of it is rolled up and shoved into the back of a closet. Sometimes a corner or length of it falls out for you to look at, and you find the fabric is not neatly rolled at all, but just stacked and crumpled fold upon unkempt fold, creased and wrinkled with numberless crannies, nooks, seams and moth holes where everything you ever saw, heard, smelled, felt, thought or said is stored. The longer you live, the more information is enfolded in the wrinkles. The deeper the blanket of memory becomes, the heavier and harder to smooth out it is.

* * *

Even scientists who have thought hard about it have only the barest clues to what time actually is.

We assume it has some kind of objective existence because we live in it. It carries every one and every thing inescapably along. The Sun rises and then sets every day. Summer turns into fall, fall into winter, winter into spring, spring to summer, year after year. The Moon, planets and stars wind overhead in daily, yearly and longer cycles. We're most intimately aware of time in our own memories and in being carried unstoppably straight toward death.

According to our observation, time is a continuous motion of some kind forward. Isaac Newton stated it for mechanical science in the 1660s: "absolute, true, and mathematical time" flows at one exact rate everywhere. For about two hundred and fifty years this was the best scientific description of how time seems to work. A continuous, measurable flow.

Except, it turned out time is not an absolute flow at all. About a hundred years ago Albert Einstein showed that intervals of time are not the same for everyone. (Not psychologically – that's a different problem.) But the same interval of time can be physically, measurably longer and shorter according to how fast you're moving in relation to the speed of light or how close you are to a massive object like a planet.

Light travels about 186,000 miles per second. At or near that speed, time intervals shrink noticeably. Meaning that, for example, a year for a person traveling near the speed of light is shorter than a year for a stationary person. So if one person traveled into space at, say, 80 percent of the speed of light and returned when his very accurate spacecraft clocks measured twelve years, then when he got back, twenty years would have passed for a person who remained stationary.

According to Einstein, gravity also affects time. For a person on Earth's surface, gravity causes time to move physically, measurably more slowly than for a person farther out.

Now, Earth-surface time is not the "real" or "correct" time. Times measured at different distances from Earth, or at different velocities, are accurate even though they're different. There is no single absolute flow of time. This has been shown in jet planes and subatomic particles. In 1971 two physics professors flew atomic clocks on jets around the world. In the end, the jet-based clocks differed from synchronized Earth-based clocks by 59 billionths of a second going east and 273 billionths of a second going west. (The differences differed because the Earth's gravity and rotation also affect our experience of time even though we have no idea it's happening.) The variations were tiny because the jets were traveling at a tiny fraction of light speed. Likewise, in 1966, some scientists accelerated muons (a species of subatomic particles) to 99.7 percent of light speed and found the speeding muons, which have very precise life spans, lived twelve times longer than muons at rest.

In 2010 a team of scientists reported they set up two atomic clocks on tables differing by about a foot in height and found the clocks detected time differences – due to one table being closer to Earth and its gravity – at a rate of 90 billionths of a second in seventy-nine years. Tiny differences that prove Einstein's theory of relativity is accurate to the real physical world.

It all points to he fact that time is not a flow: It is a dimension. Or more accurately: Time is our experience of the fourth dimension.

* * *

Apparently we are trapped here. As far as we can tell, we are carried in time with no detours from one moment to the next, today into tomorrow, this year into next, summer to winter, birth to death. We  pinned to now, like canoeists with no paddles – we can't go back downstream and can't drive ahead. Neither the past nor the future exists; there is only the now and here of the boat.

But if relativity theory is correct – and it appears to be – then this experience of time as a flow on one point is an illusion. Despite our experience, time is not a flow at all, but a dimension with plottable points, like in space. In fact, space and time are not two things interacting with each other, but one continuum, which the physicists call space-time.

Here's one of the ways this riddle gets worked out.

When we think of space, we think of locations in the three dimensions. I'll meet you on Main Street (a length) at its intersection with Hammond Street (which runs into Main Street from a width) on the second floor of the Thai restaurant building (a height). If either of us gets any of those three locations – length, width, height – wrong, we'll miss each other because we'll be in different locations.

But think about it: We have to be there at a the same time, too. So to locate ourselves accurately, we name a fourth dimension, say, 4:20 p.m. In this way, space and time are bound up with each other even in our everyday experience.

Here's a further way of thinking about it. Troy, Maine, is a location in space, and Bangor is a different location in space. When I'm in Troy, I'm not in Bangor, and so in a way, to me Bangor does not exist since I'm not there.

In the same way, 4 p.m. is a location in time, the way Troy is a location in space. When I'm in 4 p.m. Tuesday, I'm not in 2 p.m. Tuesday. So to me, at 4 p.m., 2 p.m. does not exist, the way Bangor does not seem to exist when I'm in Troy.

Yet I know Bangor is still there, it's just out of sight. If Bangor still exists when I'm in Troy, why can't 2 p.m. still exist when I'm in 4 p.m.?

The scientific answer is: It does.

Past, present and future, according to the physicists, exist all together simultaneously as the dimension of time, the way up, down and sideways all exist together as space. Physicists call this unified co-existence of all times "block time," a phrase parallel to the philosophical term "eternity." It refers to the idea that all time and space exist at once – space-time. In other words, it's likely that 2 p.m. Tuesday does still exist, you just can't get there from here the way you can get from Troy to Bangor.

No one knows why you can choose to travel from Troy to Bangor but you can't choose to travel from 4 p.m. back to 2 p.m. and have no choice but to travel from 4 p.m. to 6 p.m. For reasons utterly unknown, we experience the fourth dimension in what seem like moments flowing in just one direction, morning to night, summer to fall, birth to death.

Einstein was quite bothered by this part of the riddle. He suggested that we separate past, present and future in our minds to keep life orderly. If everything was happening to us at once, we couldn't handle it. Humankind cannot bear very much reality. That doesn't explain anything, though. It just observes a psychological benefit of our experience of time.

Physicists call the apparent motion forward "the arrow of time." They think it's related to the fact that when left to themselves, things tend to come apart rather than assemble, a tendency called by the technical term "entropy."

Personally, I find this less convincing as an explanation than Einstein's observation that we would go mad if we experienced everything as it really is – simultaneous. The "arrow of time" is little more than a technical metaphor for an experience. It is not an explanation at all.

* * *

According to the maps of time made since the middle of the twentieth century, even though you are comfortably reading these pages on, say, a rainy afternoon, you are somehow – somehow – still drinking this morning's coffee.

And you are simultaneously eating tomorrow's breakfast, and tomorrow's, and tomorrow's, a notion that seems sort of idiotic. But according to the calculations of modern physics, all our yesterdays and tomorrows, despite our experience of now, exist simultaneously in the space-time continuum.

How could this be.

We tend to think of time as linear, moving like an arrow in a line from the past to the future:

__>__________________>__________________>_____

**YESTERDAY** **NOW** **TOMORROW**

Along the line to the left are all the events, all the morning coffees, that actually happened. Along the line to the right are all the evening suppers that will happen in the future. To us, these events and moments come into our experience from nothing and then pass away into memory, and they seem to be the only ones that exist.

But according to most physicists, this diagram is incomplete. All of time is not arrowing forward along a horizontal line any more than all of space is the road from Troy to Bangor. Time is a dimension, more like a block than a line. The diagram needs a vertical axis to indicate, above and below the line, time we don't experience:

So we're saying time also exists above and below the line we're on. What time is it there?

The short answer is that no one knows. But physicists have observed behaviors of light, made mathematical calculations, and applied logic that all indicate the time off the line does exist. What's more, it probably includes everything that didn't happen as well as everything that did. In other words, the whole area to the left of Now represents every morning coffee you remember having as well as every coffee you could have had but didn't –

every event and possible event that led to Now. And the whole area to the right contains everything that will and could happen.

You can draw a line from the left to represent the sequence of events that led from the moment you got out of bed to your cowlick-fuzzy walk to the kitchen and the coffee pot and everything up to Now, when you're reading this book. The physicists call that a "world line" – the line representing a sequence of events in time. And you could continue the line on into Tomorrow to represent everything you will do leading to supper. Of course, you don't yet know what those events are. But that doesn't stop the line from existing.

An infinite number of events *could* have led to Now (you might have gone to the bathroom before you went to the kitchen), and so an infinite number of lines converge from the left onto the point where you are Now, reading. After you finish reading, an infinite number of events might happen, so an infinite number of lines radiate to the right toward Tomorrow. If you were to include all those lines leading to and from Now, the diagram would look like two cones touching at the tips.

Now it gets weird: Good evidence from quantum physics indicates that even though you apparently lived in just one of the possible sequences of events, where you had coffee, the others – where you went to the bathroom first, or had tea instead of coffee, or didn't have breakfast at all – nonetheless happen as well. Those events are in the area above and below the time line.

Some physicists call that area "imaginary time," which is a phrase titillating to the science fiction-loving mind, but it doesn't mean what you think. Imaginary time can be calculated.

There are relatively simple formulas for computing space-time differences between two events. For example, an event happening at 1 p.m. on the Earth is about 93 million miles away from an event happening at 1:05 p.m. on the Sun. Figuring the time difference of the two events is complicated because 1 p.m. on Earth is not exactly five minutes from 1:05 p.m. on the Sun. It takes light about eight minutes to get from the Sun to the Earth, so the travel time changes the time relationship between the two events. In other words, calculations of time are tied to the speed of light.

By working out a formula that includes taking the square root of a huge number related to the speed of light (186,000 miles per second), physicists can get a number that represents the space-time interval between the Earth and Sun events. But if two events differ over a spatial distance that light cannot cover during the time difference (like 1 p.m. on Earth and 1:10 p.m. on the Sun – more than the eight-minute light-trip between the two), then the square root has to come from a negative number – and as you might remember from algebra class, negative numbers have no square root.

The two events, though, do happen, even though their distance outstrips the ability of light to connect them in time as we experience it. To calculate that space-time interval outside our experience, the negative number's square root is assigned what mathematicians call an "imaginary number." That imaginary number is not on the Yesterday-Now-Tomorrow time line with real numbers. Which tells us that the two events are not connected in time as we know it. They are connected in the area above or below the time line.

The math is real, and imaginary time is real.

Behaviors of light have been observed which indicate imaginary time connects and contains, not only events outstripping the light-speed distance from the Sun to Earth or Jupiter, but also events that did not happen on the time line. Everything that could have happened over in the left area of the diagram, did happen, and everything that could happen over on the right, will happen. Or more accurately in block-speak: It is all happening all the time. Tomorrow and tomorrow and tomorrow all creep simultaneously, and all our yesterdays have lighted the way to untold deaths and everything in between. In other words, the best scientific evidence – as infuriating as it seems to common sense – is that the whole of time and all its possibilities are one colossal Now.

* * *

A lot of scientists and mathematicians are pretty sure there are more than four dimensions in the universe.

A good many physicists are convinced by the mathematical equations that there is a fifth dimension. Some of them are pretty sure there are ten or eleven dimensions, and a few think there may be twenty-six. All here, now, with us, but unseen and apparently unexperienced by us.

The reason the physicists think so is actually pretty simple. The math (which apparently is correct) that represents behaviors of light in quantum physics and the math (also correct) that represents behaviors of gravity in relativity physics, do not jibe. That is, they do not jibe when calculated in the four dimensions where we live. However, when the calculations are made on the assumption there are eleven dimensions, most all the math falls neatly into place. In other words, according to the math – and since no equations have been found that solve the problems in four-dimensions – there have to be higher dimensions. In fact, the equations imply that light is generated by ripples in the fifth dimension.

If there is a fifth dimension, where is it? The physicists' answer to this question is: It is too small to see.

What could this mean? When you rise through the three spatial dimensions, they get staggeringly larger. One dimension is a line. Pull that into two dimensions, and you get a plane, which in area is like the difference between the road to Bangor and the Earth's surface. Pull a plane into three dimensions and you get a cube, or the difference between the surface of Earth and all the rest of space out to the quasars.

Pull a cube into four dimensions and you get – what? Well, you'd get the fifth dimension which is described as the fourth spatial dimension, since time is not spatial but instead temporal (meaning related to our experience of time rather than our experience of space). The physicists call a cube pulled into the fourth spatial dimension a "tesseract."

What could the fourth spatial dimension look like, from our view?

It turns out that, according to the mathematics, the higher dimensions are very large in surface area, but vanishingly small in volume. A higher dimension is akin to the whole surface of the Earth rolled up into a tiny tube. If you could somehow see it, it would look like a hair or a pencil at a distance; but inside is a vast surface curled up on itself.

The physicists who work on "string theory" (whose math solves a great many physics problems that so far are intractable if the universe is only four-dimensional) theorize that the visible universe develops out of the vibration of subatomic strings in these other dimensions. They think we may be living on the surface of one of these dimensions, and all space and time are just a thin membrane among ten or eleven "branes."

I don't know what this means, either. How a dimension can be large or small, I don't know. But no one knows really, because, beyond drawing hypothetical diagrams of extra-dimensional Euclidean shapes, no one has ever visualized any dimension beyond the basic three.

The two-dimensional world, if you could go there, would be flat. As far as you knew, the only existing space would be in front and in back of you and from side to side because you would exist in a plane. Like a slug crawling along flat earth or rotting planks, you would have no way to imagine the next direction after wide – up and down. Your geometry would all be flat. You could draw a box, but not a cube. You could draw a circle but not a sphere. You could draw lines of radiuses going out from the center of a circle to its edge. You would be able to observe that the number of possible radiuses is infinite. But since there was no up or down, and therefore no sphere, you would know nothing about the infinity of possible radiuses shooting off into the depths of space.

Presumably time would be carrying everything along in roughly the same kind of motion we experience here in three-dimensional space. And, presumably, there would be no stars. But there might be suggestions of a third dimension. The flat path of the slug might turn out to be a plant stalk, though the experience of it might be in the range of “more toilsome” rather than “up.” A robin swooping down to snatch the slug is coming from nowhere, as far as the slug is concerned.

But suppose, based on your curiosity about these intimations, you refined your flat geometry to a point where your equations started suggesting there was a third spatial dimension – depth. You still would not be able to see it. But your equations might suggest a rise could be unfolding from the plane that might account for your sense of “more toilsome.” What planar distance would that rise be? Maybe the first rise you’d notice would be the first possible radius in the infinity of radiuses that (we here in three-dimensional space know) can be drawn out toward the edge of a sphere. Sort of like the first sliver of light visible just upon sunrise.

The first possible plane rising at an angle from a flat surface would be extremely close to the surface. It would be *vanishingly* close, more like a tiny, tiny wrinkle. And so the angle between the flat surface and the risen plane would be vanishingly small. Your flat-surface mathematics might provide you with a way to predict a measure for that angle, and to give a hypothetical distance between the risen plane and the flat surface near where they meet. That distance would be so small that for all intents and purposes, it would barely exist. So you would say: There is mathematical evidence to suggest there is a third spatial dimension, *but it is vanishingly small*.

Now, we who live here in three dimensions of space know that that third dimension, depth, is not vanishingly small. It extends in all directions into depths so enormous that we measure them by time. The third dimension reveals to us, not only the robin, but the stars.

What if the equations of four-dimensional space-time that imply a vanishingly small fifth dimension are indicating just the first rise and angle out of depth? That fifth dimension, like depth unfolding out of length and width, would seem vanishingly small but actually be so enormous it is beyond the measure of time itself, and the stars.

* * *

In August 2000, Jack and I traveled to China. He was nine, I was forty-seven. For decades I had wondered what life would be like in The Year 2000, but did not imagine this.

We spent a week in Beijing, got sick on the food eventually, and then flew to Shanghai, where I set up shop teaching American literature at Fudan University. The Chinese people were very friendly and attentive to us at first. They knew our minds would be boggled for a while, though most of them did not really know what that meant. Their experience told them we would be acting more peculiarly at first than we would after we got adjusted – after which, they were quite well aware, we would still act peculiarly but no longer like we were drunk.

How is China different from North America? To say that the food was, well, unfamiliar is to graze only the very surface of a deep tarn of profound otherness. We had already lived in Bulgaria and thought that culture, situated as it is in a sort of no-man's-land between Asia and Europe, was profoundly different from America. But compared to Shanghai, the city of Blagoevgrad seemed not much more different from Portland than Troy seems from Bangor. Cyrillic letters differ from Roman, but they signify meaning in the same way. A Chinese word, on the other hand, is as different from an English word as the Moon is from the Sun. The thoughts, expressions and psychic and moral energies of China are virtually inside out of ours. We live in just utterly different worlds.

Anyway, during the first week in Shanghai-world, Jack started school. A van picked him up every morning at the gate of our building in northwest Shanghai, trundled through back streets and past the Bund, then onto a connector highway carrying him and some of his schoolmates to the Shanghai Changning International School. He got settled into this routine pretty quickly, though changes like this for a kid can go beyond mind-boggling into the range of traumatic. But Jack had already lived in Bulgaria, walked around in worlds as different as Firenze, Athens, Timisoara and Istanbul, and had spoken Bulgarian. He was always an excellent traveler.

About a month into our Shanghai adventure he reported to me that he noticed blood in his stool. So we tracked down a Chinese-American doctor who said it was probably a side-effect of culture shock, primarily adjusting to new food and water. But we should let a Western doctor take a look, he said, and advised us to go to a children's hospital in Hong Kong for a colonoscopy. Jack was quiet and patient.

We called his mom, Bonnie (who was to join us in January), and told her what was going on. He was talking to her on the land line phone in the red-furnitured, red-draped living room of our little apartment in the Fudan University Foreign Experts Building. She asked him what he thought we should do. He was looking at the floor, holding the phone to his right ear. His cool bravery was startling.

"It's my health," he said calmly. "Let's do it."

In the middle of October we flew to Hong Kong, briefly visited the doctor, a peremptory Scotsman with fake kindliness, found our hotel in the Causeway Bay area and spent a fitful night waiting for the bowel-cleansing drug to kick into action. It never did until we were in a taxi winding up steep hillsides in the early morning darkness. Jack quietly endured it and controlled his body and his state of mind.

The children's hospital was nearly at the peak of one of those high, conical Hong Kong hills. It was a relatively old building, probably built in the first half of the twentieth century, with hardwood floors and painted woodwork.

I sat outside the operation room in the bleak fluorescent hospital lights with more anxiety than I have ever felt in my life. Soon they wheeled him out. His face was ashen and he was still asleep. The doctor reported there was nothing to report.

The nurse, a kindly middle-aged Chinese man with big glasses, put Jack in a bed in the recovery room. This was a large open room like a school play area with several beds, low book shelves and crates of toys. Large picture windows looked toward the bay. The sky was gray and rags of fog blew through gnarled tropical trees outside.

It was quiet, with sometimes an echo of voices far down the hallway. One other child was sleeping in a bed across the room.

I sat by Jack's bed and watched him sleep with an IV feed still in his arm. Soon this was removed and Jack went from asleep to groggy to sick to alert over a little while. The nurse was extremely kind to Jack and to me.

These hours in the recovery room in the children's hospital in Hong Kong are burned so deep into my memory I expect I will remember them in other lifetimes. The worn hardwood floors, the smell of old varnish, the shelves of picture books and toys, the quiet, the hillside trees worn-looking in the gray foggy wind, a plate of thin, dry, kindly offered toast, and Jack lying in the bed, sick and weak but slowly brightening, completely patient and completely brave. I already loved him more than I ever loved anyone in my life, but those hours swelled to another level of sky. Sympathy and protectiveness, awe, admiration and love never known to me before saturated the very minutes themselves. Everything I know of Jack resonates off those hours in Hong Kong.

In the afternoon we got a taxi back to the hotel. The sky cleared, the sweaty Hong Kong autumn heat returned, and Jack wanted to walk around in the teeming narrow streets, so we did.

* * *

Twelve years later the force of those feelings has not subsided. I saw Jack's largeness in the face of pain again when he was in high school and got kicked square in the nose during a soccer game, blood everywhere, the nose fractured, but his disposition, exactly the same as in Hong Kong, was quietly enduring, even cheerful.

Those are resonances in time, like harmonics vibrating forward and backward from a point touched on a string. The physical touch is no longer occurring, but its sound – the emotion – is fully alive. A memory is like a touch on a vibrating string. It's also like a prism, where visual, olfactory and especially auditory recollections project emotions like beams of light from the past directly into the present. The incidents are far away, but the emotions are still present and available. The emotions are actually, in reality, relived again and again. How can events long past still be occurring?

The answer is that events in the past are, as the physicists indicate, still occurring. Our bodies for some unknown reason are no longer there, but somehow, our minds are still connected there.

Time then develops out of a relationship of the mind to the dimensions. There is no absolute flow of "time," as our everyday common sense tells us. All time, past, present and future is an eternal continuum, and the same way you can travel through space to get to the next town, you can touch the past, at least, in emotions that are channeling, in some cases undiminished, from one spot in time to another. "What thou lovest well remains," says Pound in one of his most penetrating moments, “the rest is dross.”

And yet there remains this relentless sense of the arrow forward, from morning to evening, from birth to death, whose main feature is that what is behind can be seen but what is ahead is largely invisible. This invisibility of the future is true to everyone’s general experience, although most people have experienced or heard of incidents of precognition and of cognition of events unconnected in physical space – and meticulous scientific studies have concluded beyond reasonable doubt that “anomalous cognition is possible and has been demonstrated.”[10]

So every day we live in a three-way paradox: the apparently inescapable experience of time in motion from past toward the future; the undeniable experience of emotions connected with past events existing in the present; and sound scientific indications that all events exist all the time, meaning time in essence does not objectively exist, or exists to us only as an illusion.

* * *

There is one more curiosity to observe about our experience of time: It seems to move at different velocities.

Short-term time drags almost painfully during boredom or unpleasantness, while during intense concentration or pleasure it speeds up and at points even vanishes. And long-term time seems to gain velocity with age; a year is to a nine-year-old as a decade is to a fifty-nine-year-old. The trip to Hong Kong is much further in Jack’s past than it is in mine.

Why does time seem to accelerate with age? Partly because we sense death nearing, I think, and partly because the memory notices recurrent points of orientation on which resonances arise and directly connect more and more points on the continuum. Even small events like blossom-times and first snowfalls by repetition become familiar and the details clearer and so more vivid in memory. That sensory vividness becomes a clearer and clearer prism for even wispy emotions that you notice arise with the first red buds of maple or the first gray swirls of snowflakes, year after year. Small emotions refracted through repeated sensory events make shortcuts in time that soon create a webwork unifying many different times. “Your love of many things,” Rumi says in Coleman Barks’s translation, “proves they’re one.” You are connected more and more closely to the past. The acceleration of time is the partial breakdown of the arrow illusion.

And yet, paradoxically, its vanishment accelerates the sense that it is moving. It’s like the motion of a tether ball. When you’re young, the ball is making a very wide dizzying circle from summer slowly around the other side to winter. At some point you notice it always returns to summer. As you get older, the tether wraps tighter to the pole, and the ball makes a smaller, quicker circle. Summer seems to arrive a little sooner. Soon the ball is whipping around the pole and shortening with every pass through summer, and by the end, the tether is tight to the pole and the ball is whipping around so fast it is in virtually the same space all the time. Momentarily, it will come to rest.

* * *

Our experience of time whipping us around like this can become a sort of vertigo, if you pay attention to it without finding a way to maintain your balance.

*Are the trees moving, or is the mind moving?* ask the old Buddhists.

For if, despite our experience, there is as the physicists state no absolute flow of time, and time is an illusion, then our minds, somehow, are creating it to adapt our three-dimensional physical bodies to the fourth dimension. And perhaps our consciousness. Could humankind bear to experience everything all at once?

So our bodies and present consciousness are disconnected from past and future events, but our biochemistry provides a direct perception of the past, at least, in memory, which channels the actual motions harmonically through the dimensions.

The vast structure of recollection where these emotions, intuitions and higher apperceptions exist is like a fabric. The memories are stored in the fabric. The fabric (to speak more scientifically) is thought by some researchers to be a quantum hologram in which information about every event that ever happened or could have happened is encoded in the interaction of quantum particles – which are thought to form a sort of substrate of the universe. Consciousness is thought to participate in, or be able to access this substrate of information. “The information carried by a quantum hologram encodes the complete event history of [an] object with respect to its three dimensional environment,” summarizes Edgar Mitchell. In a different, religious context this warehouse of encoded information is called the Akashic Records.

The longer you live, the heavier your fabric becomes with information – an accumulation of details of directly connected memories – tucked into and between the folds, wrinkles and nooks in your mind.

Somehow, you feel by a certain age, you have got to put this weight to rest.

* * *

To still the flow of time, still the mind.

Bye and bye is easily said. But sometimes, late in the afternoon in September and October, a certain slant of sunlight angles in through red and yellow leaves that for all the world are prismatic. This light is unseen at any other time of year. The sumac leaves and skeleton goldenrod and even horseweed radiate energy that practically sets the day on fire. The dry brown stalks in fields and inflorescences of fading grass are illuminated as if from inside. The angle of the light pries something loose. The mind finds itself inside those shafts and colors. The silence itself is a strain of music. The landscape listens. For a moment there is a sense that this autumn afternoon is the whole of autumn, all autumns from childhood up through autumns yet to come.

It unfolds out of the branches. Every scarlet leaf is a facet in a prism. Every reed, every stalk of sedge is refracting a glimpse of the first angle up in the fourth dimension. It is a vanishingly small angle, a tiny wrinkle, extremely close to the surface of space, at the still point of the turning light.

To keep a scientific eye in that light takes superhuman patience and single-pointed concentration. The maples, Thoreau observed, are "the most beautiful of all tangible things." Their red leaves, and the copper beech leaves, purple grasses and burst milkweed pods are in that clear light prisms of things unseen, directing an otherwise invisible glint of the infinite block of time onto your retina and transforming it there, right in the same angle where the sea and sun vanish into each other.

In the crystal clear autumn sunlight, the deeps of time are as near to tangible as they can get and not kill you.

* * *

I do not claim to know what any of this means. There are angles of light everywhere. Deep inside them are all the lost friends, the sunsets, raucous nights and afternoon ennui, mean things done and said, sprained ankles, taste of cake, cups of coffee, giant girlfriend, pot of duck tongues, smoke, coffee, a rainbow, coffee, three men walk into a bar, a shooting star, a beach, a birth, a mid-May evening, two-legged leap in the air with a wailing guitar, the odor of old varnish. And where did my mother go?

Are the angles of memory inaccurate to the math of three dimensions? All I can tell you is: the hardwood floor of that children's hospital on the mountainside in Hong Kong is more real and weighty to me than this morning's coffee, and remains more easily located in the fabrics of time than anything I ever experienced, and will do, for at least as long as I last here on Earth.

# THE ACCIDENTAL UNIVERSE

In a general sense, modern science assumes that everything that happens, has happened and ever will happen is a result of random occurrences within ranges of probability. Like, for example, whether a coin flipped into the air will land heads up or tails up. It's a matter of pure chance in which the range of probability is 50-50. It's random, or stochastic.

The ranges of probability are framed by what are still called the "physical laws" of the universe. This phrase could cause a lot of trouble for us if we ask too many questions about what it means, exactly. So we won't go there right now.

But for an example of the stochastic universe that does not involve a penny, take the origin of life. It is generally believed that life began by chance. Certain organic chemicals arrived here already formed on meteorites from outer space, or assembled themselves in Earth's early environment, and were shocked by impacts, ultraviolet light or electrical discharges and developed a chemistry of self-replication. Which is to say, life. This is thought to have happened by accident. The probability of it is astronomically low, approaching the range of impossible. But obviously, it did.

For nearly 3 billion years, there was not much change in the self-replicating systems, which is to say, bacteria and algae. Then some unknown, unexplained event happened by accident and the single-celled systems began to complexify into multicelled systems. After that all hell broke loose. Accident after accident happened, which in evolutionary theory is called mutation, and the single-celled bacteria began turning into plankton, seaweed, clams, fish, grass, dragonflies, dinosaurs, roses, rattlesnakes, kangaroos, pine trees and humans. Not necessarily in that order.

Somewhere in there – we have no way of knowing when because we have no direct experience or evidence of what animals other than humans actually experience – a very complex thing popped into existence: awareness. Since (it is assumed) every development that came before it resulted from chemical changes, it is also assumed that awareness is a byproduct of chemicals firing in your brain. There is a name for this assumption. It is called "epiphenomenalism."

Epiphenomenalism makes sense to most scientists because to them it's self-evident that everything is a physical process. What else is there? First there was energy. Then the energy accidentally coalesced into physical particles. Then the particles accidentally began channeling energy. Then the interactions between channeling particles became so complicated that they became aware of themselves. I.e., you reading these words.

One trouble with this way of looking at the world is that it means you personally – the you that is having experiences and is aware of it – do not actually exist. You are just chemicals going off and creating the illusion that you are something, when really you are nothing, just chemicals and accidents. You are not making any decisions about what you do, say or think. Chemicals are doing that, and creating the illusion that you are doing it.

To rephrase the warning of one botanical scientist, it is important to remember that a human being is nothing more than a cluster of nerve, blood and flesh cells channeling energy in a way that accidentally allows them to perceive and analyze their surroundings and seem to appreciate them. There is no such thing as you, there is no such thing as beauty, and there is no such thing as "right" or "wrong" because you are not doing anything, chemicals are.

And it's kind of silly to wonder where those pre-existing physical laws came from. It's all just accidents waiting to happen.

## THE PLEROMA

*"All There is light and beauty, through and through,*
*for the beauty is no mere bloom upon the surface."*
**– Plotinus, *Ennead* V.8.10**

The universe is expanding. All the galaxies, stars and solar systems are flying wildly outward in all possible directions. So far as anyone can tell, this has been happening for something more than 13 billion years, and so we say the edge of the universe is that far away.

Apart from stating that the edge of the universe recedes from us, there is no way to locate it. At the cosmic scale space is identical with time, and since light travels faster than any other physical phenomenon, the distances of objects beyond the solar system are measured by the time it takes light to travel between them. The edge of the universe is thought to be somewhere around 13.7 billion light years away.

Saying the universe is expanding at a rate beyond any real human understanding solves a lot of cosmological problems for science. One problem it helps solve is Olbers' paradox. Wilhelm Olbers pointed out in the early 1800s that if the universe is infinite, then there must be an infinite number of stars, and if there is an infinite number of stars, then the whole sky should be flooded with light all the time. There should be no darkness. In an expanding universe, however, light from most of the stars that exist has not yet reached us, and so the night sky is only lit in spatters.

It is also an apparent fact of physics that the luminosity of a star declines in proportion to the square of its distance from the Earth. This is because the star's light expands spherically outward from the star, and the more it expands, the more space it has to fill. By the time the starlight reaches the Earth, it is filling an enormous volume, and that volume is expanding even as the light fills it. The same quantity of light, presumably, fills a geometrically expanding area, and so it is diluted, and so another reason the sky is dark may be that there simply aren't enough stars living long enough to generate that much visible light.

The sky is nevertheless filled with light of all kinds, although we see only a small portion of it. "Visible light" is electromagnetic radiation moving in waves which are between 7,000 and 4,000 angstrom units in length. An angstrom unit is about .0000001 meter, and the range of wavelengths visible to us is tiny in comparison to all the light that exists. Light of just slightly longer wavelengths is called infrared light, and wavelengths somewhat longer than infrared are called radio waves. Wavelengths just slightly shorter than visible light's are ultraviolet. Shorter than ultraviolet are different kinds of X-rays, and the shortest wavelengths of light anyone knows about are gamma rays, a form of intense radiation.

In 1964 two scientists were wondering what the fuzzy noise on their special radio all the time could be, and they figured out it was electromagnetic radiation left over from the Big Bang. They had found hard evidence that the universe was finite, that is, that it had a beginning.

Most present-day cosmological theories propose that the universe began at a tiny point containing all potential energy. It exploded and began to radiate outward. It formed atoms along, maybe, cracks or strings in the fabric of the expansion, and then where clumps gathered, the materials which eventually became galaxies formed. One problem with this theory is that 13.7 billion years does not appear to be long enough for galaxies to have evolved. Cosmologists are working on it.

An offshoot of this theory is that the universe's expansion grows slower and slower as time goes on. All the matter generated in the universe exerts a gravitational force that brakes and eventually stops the expansion. At some point, not any sooner than 10 billion years from now (states the theory), the universe will stop expanding altogether and begin to contract. It will contract faster and faster until it collapses back to its original pinpoint of potential. Then, sufficiently compressed, it will explode again. One problem with this theory is that no one has been able to take a measurement showing enough matter in the universe to exert a gravitational tug big enough to slow down the expansion. On the other hand, many cosmologists think that up to ninety percent of all the matter in the universe is "dark matter" anyway, at the moment undetectable to us.

The general idea that the universe had an explosive origin is not really new. The first verses of *Genesis*, as most people have noticed at one time or another, make a striking figurative parallel with the Big Bang theory. And the idea that the universe runs forward and then halts and runs backwards again is not new either. In the *Statesman* Plato explains such a story in some detail. Today's scientific models differ from biblical and Platonic myths, of course, in the body of factual and mathematical evidence, together with four hundred years of scientific reasoning, brought to bear on solving physical problems of space and time.

The problems of spatial location are intimately related to problems of chronology. Einstein showed through his mathematics that time and space are essentially the same thing. Not surprisingly, the ancients intimated this, as well. In the ancient world time was measured directly by the motion (motion meaning changes in spatial location) of the Sun, Moon, planets and stars. The celestial bodies formed a living, moving image of eternity, and were in quite literal senses divinity itself, or the aspect of divinity you could detect with your eyes. Light is also a powerful symbol of God.

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Time tumbles on. In modern terms the universe is a perpetual series of statistical accidents. The world looks like it does and moves like it does because of a tendency for things to become disorderly. In other words, there are always many different ways for a clump of things to exist apart in a jumble, like the pieces of a jigsaw puzzle for example, but only one way for them to exist together in order. Since the universe is in a state of constant flux, when things change they tend to arrange themselves in one of the many chances for disorder, rather than in the single lottery-like chance for order. This tendency toward disorder is called entropy. Another theory of what might happen to the universe is that all matter could burn itself out of order and devolve into radiation. It will be a universe of pure light-chaos.

There are of course some perplexing exceptions to the rule of entropy, and they seem to get ignored in basic textbooks. For example, if things tend toward disorder, then why did galaxies – which are in general fairly orderly, compared to the scale on which groups of stars could be disorderly – form? Why are stars, highly complex beings, constantly coming into existence, persisting for long periods of time and then extinguishing in one way or another, only to form new stars from their remains? Why are the stars, in most galaxies, circulating serenely and obediently around a central point?

And why do the gargantuanly huge spaces between stars cause the stars to seem utterly stationary and orderly, even after moving thousands of miles per second for tens of thousands of years? Why do the constellations circle so predictably, century after century, revolving in yearly, and even longer, cycles? You can always tell where you are and what time of year you occupy by observing the Big Dipper and Polaris carefully at the same time each evening. Despite the appearance of constant local decay, an innate order clearly underlies the perpetualities of the universe. The evidence is everywhere, available to the senses, the intellect and the intuition, among other things.

Even more exceptional, in an entropic universe, is life itself. The universe is expanding superhumanly outward, and following the rule of entropy, most everything is collapsing in its wake. But meanwhile life has emerged on Earth, if not elsewhere, and has burgeoned ever since. And not only has it burgeoned, but contrary to the dissolution all around it, it has become more complex, that is to say, created more intricate levels of order as it goes. A bacteria is a long-lived animal, and some say the best-adapted creature in evolutionary history because it has survived nearly the whole time while orders of other organisms have struggled up and died out across a few or many millions of years. Good for the bacteria, and good for us, who use the bacteria to keep alive.

It is a long way from an amino acid electrified by lightning to a human brain. Life on Earth, we are told, evolved quickly in the beginning, and then leveled off for quite a while. The first cellular fossils date to about 3.5 billion years ago, which means life took about a billion years to organize and appear. But the first multicellular animals do not show up until almost 3 billion years later, about 600 million years before the present. In the next approximately 70 million years, multicellular life-forms somehow constructed all their basic frameworks.

Then in the Cambrian period, in a space of time lasting between 5 million and 40 million years, there was an explosion of diversity and complexity in life forms. No one has any verifiable idea at all why this happened. One way to begin explaining it is to say that evolution tends toward complexity, which seems clear enough, given the difference between a bacteria and a human brain. Some argue, however, that evolution does not tend toward complexity. Given the "success" (meaning survival) of many simple forms and the relative paucity of successful complex forms, biological complexity appears to be accidental. Those who argue this openly admit, at the same time, to having no idea why there was an explosion of complexification 570 million years ago.

The fact, as science now understands it, is that biological life has for millions upon millions of years been expanding outward from a single point, making its way out of deep water into shallow, and from shallow water onto the beach. It has gone from the sea to the foothills, and from the foothills to the mountains. We have been looking up at the Sun and Moon, and considering their distances, long enough to create a network of inventions and collaborations complex enough to send men and robots there to look around.

The idea that this could be accidental is more mystifying than the idea that it results from some innate necessity. It is not clear how a purely accidental universe can give rise to a lower limit to the complexity of life. How can it give rise to any consistent limits or order at all? Science, while maintaining its view of a stochastically evolved material universe, is nonetheless simultaneously engaged in aligning its theories with parameters that apparently exist in nature. Here we are in the vicinity of either a contradiction or a paradox.

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Two interesting points about the human species concern its youth and its antiquity. Human beings, in evolutionary terms, are new to the planet. It depends on who you call human, but if you decide the first tool-making animals were human, then you are speaking of an animal, beginning with Homo habilis, about 2 million years old. Since evolution seems to have begun 3.5 billion years ago, this is an infant life-form. No one knows, of course, when human beings started speaking to each other, but the first campfires date to about five hundred thousand years ago, and it seems reasonable to think that if fire technology was being shared, it was probably happening through some kind of verbal instruction.

It would be hard to imagine verbal instruction, at such a time, which did not include storytelling. If any of this has any accuracy at all, it means that human beings have been telling stories to each other for half a million years. I wonder if any of the stories from the campfires of homo erectus have evolved along with us and still exist in stories of, say, Hamlet or Polaris, or if they have vanished into a universe characterized chiefly by deterioration.

By fifty thousand years ago, we were essentially who we are, Homo sapiens. What stories did Cro-Magnon humans tell about the stars? Have we, or our minds, become more or less complex since that time? Could Cro-Magnon tribes, given the tools and methodologies, have built and flown Apollo 11?

Some scientists say so. But pretty surely our most distant conscious ancestors, when they looked into the sky, saw a different kind of order than we see. We have learned to see rock, gas and fire objects of varying sizes and temperatures. They saw, apparently, eternity continuously revolving. They noticed the stars moving with nearly perfect cyclical regularity, and the planets wandering through internal cycles of greater and lesser complexity.

To speak meaningfully of the order obviously inherent in eternity, you need to say things that relate as intimately to human beings as to the figures themselves. To express what happens in the sky for all time, but lacking objective technologies and information, you would frame stories that interconnect the life of a human being to the life of the cosmos.

Life is in the stars. The Great Bear circling Polaris is not merely an act of fantasy for purposes of entertainment on frozen North American nights, but an unfolding figure of the track the stars make around a central axis. If myth can be believed in any sense, the idea of what is *central* has been important to human beings for a very long time. We have been calculating the locations and distances of the stars for tens of thousands of years and only recently reduced them to terrestrial measures, like miles or light-years.

In ancient times, what was central was *outward*. The whole sky turns around a point due north, and the wanderers themselves revolve on paths along a plane parallel with the turning. If there is a central place or time, it is not here on Earth, but at a place in the sky around which all things somehow revolve. Since all things turn in order around the center, it must behoove a human being to align him or herself with that outward center too. Lacking the physical magnitude or power to vault oneself into the stars, a human being, in trying to center him or herself, would turn inward. The real orientation of a human being to the stars depends not on individual physical proximity, but on a relation. The relation is established inwardly. The journey outward is for human beings a journey inward to establish a relation with the cosmos. Even feats of sending robots and people to other planets are primarily acts of imagination, acts of the mind orienting itself to particular conditions of the universe and unfolding, in this case, physical possibilities.

Orienting ourselves to the physical sky has not, however, brought us closer to the center. In fact our relation with the universe is much more tenuous than it was when Kepler set out to prove the divine mathematical harmonies of the planets four hundred years ago. We now occupy a place so far from the center that we are 30 million light years away from it – the center is a black hole in the bulge of our galaxy – and we are in any case of no account whatsoever, being an accident of chemical chance to begin with. In our universe there is no inherent order. The revolution of the seven stars of the Big Dipper is an illusion of purely physical motion. The change of the pole star every few thousand years is a chance alignment caused by the wobble of the Earth on its axis – the precession. We have, that is to say, no relation to the universe except that we seem to occupy it.

Even the central myth of order in our time, evolution, begins to be interpreted as a meaningless stochastic process. Although with certain peculiarities.

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The theory of relativity suggests that in an expanding universe, every point is its own center because everything is flying equally away from everything else. This may only be a hopeful way of saying that there is no center.

Everything, at least, is in motion. All the stars and galaxies are flowing in definite directions, and all subatomic particles are moving with some uncertain velocity or location. All life, including individual organisms and entire species, is in motion. Everything is coming to birth, growing, decaying and dying, all moving outward.

When the universe exploded into being about 13.7 billion years ago, it went from a condition of pure potential to a condition of pure energy, and from pure energy to matter. Stars formed around clots of atoms, and then formed galaxies. It was all, as far as anyone can tell by the scientific evidence, a process of one thing transforming itself into another thing, abiding by parameters of physical behavior which, for one reason or another, were necessary for anything to happen at all. Where and how the parameters originated is so uncertain it may never be more than a matter of armchair conjecture for scientists. Things were on fire. Other things grew cold. Nothing lived for a long time.

About, perhaps, 12 billion years after the catastrophic opening of everything, something strange happened to some large organic molecules on the Earth. No one knows what it was, exactly. Surely it had something to do with how energy becomes physical matter. In the quantum universe, this implies it was a matter of pure chance, though it might simply have been following one of those inexplicable parameters of necessity. Something came alive.

This, as we say, was progress.

For three billion years it simply lived, if more and more diversely. Then it entered a period of complexification comparable on its own microcosmic scale to the original explosion. The basis for every anatomical structure now known on Earth took form and began to experiment with growing larger, occupying a particular place, or moving upward out of the primordial wet. Boneless sacs. Trilobites. Ammonites like periwinkles the size of cars and houses, swallowing things. Fish with grotesque protuberances and terrifying maws. Dinosaurs. Mammals. Human beings. The brain of Homo sapiens sapiens. Evolution, it seems has been happening against all the odds. It's as if the parameters of necessity that guide the unfoldment of the universe had blown life itself into kingdom come. The biological universe, however slowly, is expanding. The fact that no radically different anatomical form has appeared in the last 500 million years is no argument at all against a tendency toward complexity in evolution. It took a billion years for a single cell to converge and three billion more for multicellular forms to appear, and there is no reason why the next level of multicellular forms won't take another billion yet. Meanwhile, during this diverse formal stability, familial affection, social behavior, morality, and rational consciousness have unfolded from the forms.

This may or may not be progress, but it is qualitatively different from the grisly horrors of the middle stages of terrestrial life, represented in the grotesque forms of spike-backed dinosaurs and gape-mouthed reptiles. A frog is a cold-blooded, frightening thing. The gullets of some shellfish sweep the seawater completely outside the organism. The evolutionary efforts to establish a surviving form weirdly disfigure fish, the direct lineal descendants of beings from 500 million years ago, with strange whiskers and sprouting globs, spines and mashed faces. Think of a hammerhead shark, one of the oldest surviving species: It is ugly almost beyond imagination, with its shark body signifying alarming danger, its gaping mouth, and its squashed perpendicular head with eyes screwed onto the ends, like an early experiment in factory machinery.

In a mechanistic sense there is no reason to think these things are any more or less pretty or necessary than any other evolutionary organ, like the mammaries of a woman or the mane of a horse. Mechanically, the only problem is survival. From this point of view, bacteria are the greatest accomplishment of all because they have survived for virtually the whole living time and it's reasonable to expect them to keep surviving long after humans are extinct.

On the other hand, there is the physical form of a horse. Horses are not the most intelligent of all creatures. Their survival has depended on an instinct and a physical disposition for running and traveling long distances. They also have a capacity, like many other mammals but few (for example) reptiles, to learn, and part of their flourish in this day and age results from a collaboration with human beings, who are at the top of the food chain. Human beings are at the top because we, too, can learn. We can learn because of the unusual complexity of our brains.

The human brain is the latest development in complexity. Part of its complexity involves capacities to respond to the world which don't have any clear bearing on physical survival. When we see horses grazing in a field, with their rich coats and the extraordinary proportions of their haunches, shoulders and necks, the outline of the muscles in those proportions, and the ease and economy with which they move, most of us are struck in one intensity or another by the beauty of that form. We distinguish between the grace of a horse and the grotesquery of a hammerhead shark. I don't know whether dogs respond similarly to such images, or whether frogs do, or goldfish. I don't think so. Even if they do, I doubt that they make the same distinctions about their responses that human beings do; and they certainly do not feel compelled to try to understand them.

This is because their brains do not operate with the same complexity – one might safely say, the same *level* of complexity – as the human brain does. This is not a paean to the superiority of the human brain. It is an expression of an intuition of complexity. Arthur Koestler makes the altogether plausible case that the human brain is a doomed creature, an "evolutionary blunder." Its principal distinguishing feature, the neocortex, looks like an evolutionary makeshift slapped onto the original limbic system common to mammals. It's as ugly and ungainly in an abstract sense as the handles of the hammerhead. The addition of the neocortex to the mammalian brain (instead of an internal reshaping) might be responsible, argues Koestler, for the virtually schizophrenic behavior of humans in their ability to think rationally but their inability to act morally. Koestler writes, of course, with memories of the two world wars, the Spanish Civil War, the holocaust, Hiroshima and Nagasaki, the communist purges, Korea, Vietnam and countless other moral depravities fresh in mind. He points out that the sudden appearance of the neocortex in the last half million years has been compared to an evolutionary tumor.

But although it might be a dead end, the brain is nonetheless something different, even something *more* than the static recurrence of trillions upon trillions of individual bacteria. It could not have come first. It developed from a particular necessity, which is that the appearance and diversification of complex life must follow the appearance and establishment of simple life. If the physical evidence means anything, it means evolution has at least a two-dimensional movement – it branches outward from a point of origin.

A human's response to the beauty of a horse is qualitatively different from a bacterium's response to its surroundings. It's as though the bacterium, when it coalesced and first lived in the primeval ocean, awoke, in a way, from the stasis of inert matter.

For 3 billion years it lived and propagated, and then something – an impulse or a necessary accident – caused it, or its relative, to expand into the plethora of biological forms. Against all the odds of entropy, life persistently and reliably forms and re-forms its own order, almost as if it had its own determination and will. Life runs against the stochastic currents of the universe.

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The universe, we are told, is expanding from a state of pure potential energy toward a state of total inactivity, or total entropy. At time zero the universe was infinitely hot, and then it blasted open and for three hundred thousand years poured itself through an era of radiation toward a cooler, stabler era of matter. At the far end of time is a totality like the inert material substrate of the cosmos, a virtual death like that pictured on cold, rocky moons, in burnt-out stars and at the center of the Earth, what medieval theologians called Holy the Firm. It's a total material entropy that may grind everything to a halt and suck it back together 10 billion years from now.

Life too expands, but in the opposite direction, as if time and life were two screw-holes spiraling headlong into each other. Life screws toward activity and energy, toward order, while the universe screws toward disorder. Life strains and persistently jams against the spirals of time which rush it toward extinction. Bodies are born, and in a burst of energy completely counter to the decaying elements around them, they grow and come to adolescence and adulthood, where they are profoundly geared to make the prodigious expenditures of energy which create more order. The five thousand pieces of a jigsaw puzzle will fall into place by chance sooner than two clots of seawater-like chemicals will form by chance a human brain. And after their creative energies are spent, physical bodies slowly succumb to the frictions of the expansions, as if a body was a rock and time was the relentless ocean pounding it with waves and tides, grinding it into sand. The bodies, being part of the physical universe despite their efforts, are finally obliged to unwind with the universe.

All life, including the birth, creativity and death of species as well as individuals, moves against the tide of time. The entire process of evolution is a pattern of starts and stops, headway followed by unwinding. In quick, quirky bursts, like small Big Bangs, life twists up out of emptiness. At the bottom of the world are the first clumsy, violent efforts toward order. Generations of bacteria diversified and expanded, and became multi-cells in the effort. Their progeny tried on appendages and bulbs of slime, shells and rudimentary eyes. From ammonites to hammerhead sharks, and from sleeker fish to eagles and the form of a horse. The horse itself is another station along the way. And the inner response to the horse's beauty is another.

The material universe is a motion toward an outer stasis, toward a moment of nothing which can do nothing but collapse back into itself. Simultaneously, life moves not outward toward the edge of things, but toward a center. It assembles energies. The fact is that, for millions upon millions of years, life has been expanding from a spark on the outskirts of infinity, from a point where creation has unraveled to virtually nothing. Evolution is an innate motion back toward a source, at the singularity which held all potential.

Our deepest intuitions are of the existence in eternity of an origin, which science as well as religion recognizes. Why the universe should detonate, what animated organic molecules, or how the energy in photons sparks the union of a sperm and egg, science cannot explain. They are unanalyzable, perfectly whole moments where greatest simplicity and greatest complexity balance in total harmony, total potential, undifferentiated. Our deepest religious revelations revolve around this point beyond all order and disorder, at the stillness central to all motion. We live both scientifically and religiously in an intuition of that origin. Even our moral impulses spring from a perception of the unity of our species, and sometimes further, from a perception of the unity in ecologies and in whole environments. Even morality in its role as survival mechanism is a phase of complexification.

Moral impulses, intuitions of origins, and religious revelations are phases of the expansion of life toward the center of the universe. “All that is visible,” it has been observed, “must grow beyond itself into the realm of the invisible.” Life branches upward toward a pinnacle, like a spruce tree, because of a desire, not just for survival of the species or even the survival of life, but because of a desire to live inside the center of the universe. We are working our way toward the One. The realm of the invisible is pictured in the motions of the stars, which are the edge of the visible universe. While matter expands outward in perpetual dissolution, life expands back toward the central moment of creation, in an effort to align itself with the original universe.

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Plato tells us first that the universe is a living creature, and second that it runs cyclically back and forth in two directions. In one direction, the universe and everything in it moves toward order and harmony. All living things grow not older but younger, and they do not decay and die, but return to the source of their being, which to us seems like a nothingness of pure potential. After a necessary time, this cycle comes to its end and the universe reaches a climactic moment when it shifts direction and moves toward disorder and chaos. All living things then grow older and decay until they die, when time runs in this direction. “It would take long to tell of all the changes that befell the various creatures” of this direction, he says, “and show whence they arose and how they were effected, but man’s story is shorter and more relevant for us now” (*Statesman* 274b).

Strangely, despite his antiquity, Plato describes in figurative terms the same cosmogonic and evolutionary outlines described by science: The universe will expand outward and then run backward, human history is a brief flash in comparison to all that came before. We regard Plato's stories as myths, or inaccuracies, because he could not test his notion of cosmic cycles or the brevity of humanity. In any case, Plato's description suggests an unwinding universe runs backward, whereas our entropic universe is clearly – so we assume – running forward.

And Plato's stories even twenty-four hundred years ago were already part of "a mass of ancient legend." Their accuracy, our scientific epistemologies must hold, probably declines in proportion to their distance from us in time because human knowledge is a cumulative process whose time zero is about, perhaps, 1453 when Gutenberg invented movable type. How ancient are Plato's ancient legends? And who devised them?

In the *Timaeus* we learn that the Egyptian priests, long before the time of Socrates, themselves received the stories from ancient tradition. The Egyptian priest told Solon – who was young when he spoke with the priest and elderly when he spoke with Socrates – that his city was founded eight thousand years before. "There have been, and will be again," the priest told Solon, "many destructions arising out of many causes. ... Now this has the form of a myth, but really signifies the declination of the bodies moving in the heavens around the earth" (*Timaeus* 22c). The ancient myths pretty certainly were not invented wholesale in 3500 B.C. upon the invention of writing. And it is no easier to believe they originated even ten thousand years ago, since the human brain as we know it has been operational and creative for at least fifty thousand years, as evidenced at least in thirty-two thousand year old cave paintings in southern France. And having a knowledge of this sort of antiquity, we also verify Plato's assertion that man's story is far shorter than the whole story of evolution.

The whole story of all life is in the stars, which is after all where we are. We have known this in one way or another for tens or perhaps hundreds of thousands of years, and we have been telling stories about it. Not only bacteria evolve, but stories evolve, and minds, and stars and galaxies, everything grows as if it were in the throes of a perpetual explosion, like supernova light expanding from its center. And since space and time are identical, as Einstein shows us, its light unfolds not merely spherically, but four-dimensionally, through time as well as space. What cardinal direction time travels, exactly, no one knows.

We have an intuition though. If the circles of the planets and the stars, like a millstone grinding over the north pole, and the great whirlpools of galactic motion and attraction are evidence, the direction of the universe is not just outward in Cartesian space, but is crossing over, and spiraling into and out of those dimensions modern mathematicians show must of necessity exist – but which we don't perceive. We evolve toward a source whose location, like an electron's, is in principle profoundly uncertain.

Our very bodies are like subatomic particles, appearing from nothing, colliding and producing new bodies, then decaying as if to nothing. We behave like light even when we're most material, when the fantastic energy of $E = mc^2$ is locked up in skin, blood and bone and least in active evidence.

When we are in our noetic selves, we are virtually light itself. Our minds operate with the properties of photons, ideas and images appear and reappear from no apparent place, sometimes in space-time and sometimes out. Intuitions of reality emerge in Kepler and Einstein like light from excited electrons, as if, as Koestler says, from a dream. A knowledge of circumstances from across galactic times and distances – from the beginning and end of time – surfaces like bubbles that reflect the images of ancient myth or of mathematical logic. The originators of Plato's ancient legends saw and pondered the same starlight we do, but they described it by the inflection of moments rather than the infinity of mathematics.

The universe is filled with light, just as Plotinus said. It is full of lights twinkling and expanding, caressing and searing visibly and invisibly all existence. The universe is an evolving creature. It is the materialization of the potential at the origin of the Big Bang, it is full of itself, the pleroma, becoming all it can to the whole extent it can. And when it exhausts itself it will return to its original. This is not a matter of matter, dark or light, but of necessity.

# NOTES

**1. Algol.** Bohr warns, however, that an interpretation framed in language as simple as I've used here is not to be applied too literally. He says, for example: "the use of phrases like 'disturbance of phenomena by observation' or 'creation of physical attributes of objects by measurements' is hardly compatible with common language and definition" (*The Philosophical Writings of Neils Bohr*). In other words, saying "the act of watching an experiment changes its outcome" should not imply that the object of an experiment is physically changed, but that the observer is a participant in the whole process, and therefore inevitably involved in the outcome, particularly regarding the description of the outcome. Bohr emphasizes the word "wholeness" in his essay.

**2. Magnificent Desolation.** Quotations of Parmenides are from Stanley Lombardo's *Parmenides and Empedocles: The Fragments in Verse Translation*.

**3. Magnificent Desolation.** There are, of course, exceptions. Edgar Mitchell during the return journey of Apollo 14 experienced a contemplative or mystical state of consciousness, and later founded the Institute of Noetic Sciences. It was clear to him, apparently, that what happens in the mind is at least as important as what happens to the body.

**4. Fear of Mimas.** As much scientific thinking of the past seventy years implies: cf. the "anthropic principle" of cosmology, which states, basically, that the universe was for unknown reasons constructed specifically to have observers in it, i.e., our sentience can be seen as the qualitative element which fires existence as we know it.

**5. Fear of Mimas.** Physics has recently begun to monkey with even this sensibility. Frank Tipler's book *The Physics of Immortality* purports to prove, through analogy and complex mathematics, that Christian eschatology accurately and literally depicts the distant future of the universe and the human body.

**6. The Day on Fire.** Most of the factual information given here was gleaned from Zeilik and from Crannell and Russell in Meyers (see bibliography) and subsequently updated from online sources.

**7. The Day on Fire.** To convert this into the more familiar Celsius temperature scale, subtract 273: the temperature in the core is still about 15 million degrees Celsius. Or to convert this to the Fahrenheit scale, take the Celsius temperature, and make an equation: 15,000,000 = 5/9 (F-32). This makes the temperature of the core about 27 million degrees Fahrenheit.

**8. The Day on Fire.** Represented as –26, where the lower the number the brighter the object, with the star Sirius being –1.5.

**9. The Day on Fire.** Quotations of Kepler are from Wolfgang Pauli in "The Influence of Archetypal Ideas on Kepler's Theories."

**10. Fabrics of Time**. Jessica Utts, "An Assessment of the Evidence for Psychic Functioning." Edgar Mitchell in "Nature's Mind: the Quantum Hologram" similarly states: "The experience of humans is that they sometimes, perhaps often, perceive information from or about physical objects that is not available through normal, local, sensory mechanisms, nor classical space/time information. Objective testing data in overwhelming abundance provide evidence that this is true."

# LIST OF SOURCES

The following resembles a scholarly bibliography because in its first lifetime, that's what it was. It was attached to a doctoral dissertation that was submitted and approved by the State of University of New York in 1995. That was then, this is now, after probably thousands more consultations of book, periodical, and online sources to render information, quotation, and allusion as accurately as possible in tweakings of the original essays and in writings made later.

Probably this could also be titled "List of Influences," but that would shortchange the efforts, which have been extensive, to use accurate scientific information. Every fact has been derived from or checked against authoritative sources such as NASA, the Planetary Society, SEDS, and websites of university scientists and science departments, including notably Jim Kaler's *Stars* website; Wikipedia articles, most of whose astronomy and physics entries appear to be carefully monitored by authorities, also have been used as comparison sources, though never as the sole source of factual information. The factual information in earlier writings of the 1980s, '90s and early 2000s has been checked and updated where necessary for this collection.

Having said that, while the factual information here is to my knowledge solid, these essays should not be used as information sources. For one thing, since I am not a scientist, the individual facts here are all secondhand. And while the essays themselves hopefully will remain readable for some time to come, on the other hand it won't be long before the astronomers and physicists refine and revise most of the scientific figures and their descriptions of at least some of the scientific processes. When these writings began appearing in print, for example, there was no agreement on the age of the universe – authoritative sources gave figures from 10 billion to 20 billion years – but lately 13.7 billion years is the widely accepted figure. I expect that number will change in five, ten or fifty years. But like Edgar Allan Poe's *Eureka*, which uses the most up-to-date data from 1848 but is still an astonishing work in 2012, whatever value this collection has now should still obtain in the unseen future, "not in its character of Truth-Teller, but for the Beauty that abounds in its Truth."

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# ACKNOWLEDGMENTS AND DETAILS

The complete edition of *Nebulae: A Backyard Cosmography* in electronic download ($8.95) or paperback ($21.95) at http://booklocker.com/books/6276.html. or https://www.barnesandnoble.com/w/nebulae-dana-wilde/1112120342

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Quotations of Parmenides are from *Parmenides and Empedocles: The Fragments in Verse Translation* (Grey Fox Press) by explicit permission of Stanley Lombardo. Other quoted material is from texts indicated in the List of Sources.

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**Previous publications**: Most of the shorter essays in this book first appeared in the *Bangor Daily News* Amateur Naturalist column, 2005-2012. Most of the longer essays are from *Ursa Major: Essays in Outer Space*, which was the Distinguished Dissertation in the Humanities and Fine Arts at the State University of New York at Binghamton for 1995. From that work, "The Pleroma" and "The Day on Fire" also appeared in *The Antigonish Review*; "Magnificent Desolation" appeared in *Alexandria 5*; "Winter Moons" in *The North American Review*; "Fear of Mimas" in *Descant*; "Algol" in *New Myths/ MSS*; "The Parameters of Galaxies" in *The Quest*; and "A Weather Report from Venus" in *Stolen Island Review*. "Numberless" first appeared in *Xavier Review*, and "Cassiopeia" first appeared in *The*

*Antigonish Review*. A handful of the essays in *Nebulae* also appeared in *The Other End of the Driveway*, and some others have not appeared previously in print.

* * *

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**On *Nebulae*:**

*"Dana Wilde has a scientist's curiosity and a poet's imagination. I can think of no other writer who would describe our galaxy as being 'just a blur, like a wisp of spit in a lake.' This man has star marrow in his bones. Pay attention."*

***Tom Sexton,***
*Poet Laureate of Alaska (1995-2000)*
*and author of* For the Sake of the Light

**On *Ursa Major: Essays in Outer Space*:**

*"Dana Wilde writes with relaxed skill and quietly resourceful information. … These essays take a well-earned place with all such human reflection and conjecture, from Lucretius to Thoreau and onward … bridging between two patterns of [scientific and everyday] human 'worlds.'"*

***Robert Creeley***
*August 2000*